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CONTENTS OF THIS NUMBER

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The Editor's Talk With MACHINERY'S Readers

THE word "precision" took on a new meaning in the machine-building industries of America when they turned their great organizations and unequalled equipment to the production of war materials. New standards of accuracy and precision had to be set, generally speaking. Conditions in the field of war call for speed and mobility. There is then no time for fitting, trying or adjusting. The units must be right. Every part must be absolutely reliable. Failures and delays are fatal. Precious lives, hundreds, and even thousands of them, depend upon absolute precision and interchangeability. These were extraordinary requirements, unknown and unnecessary in ordinary manufacturing practice; but as soon as our manufacturers learned that great accuracy and precision were demanded, great accuracy and precision were delivered. They rose to the occasion. And it wasn't all plain sailing either, for many of the requirements imposed upon manufacturers by various departments of the government were unnecessary, and refinements that served no practical purpose were often insisted upon. It was a new business for everybody—for the men in the government as well as for the rest of us. The war is over, but some of the lessons it taught were priceless in value.

PRECISION requires gages, and accurate gages require lapping operations. Previous to the war, lapping was used and understood only by a few gage and tool makers. Now it has taken a definite place in machine shop practice, not only in gage making—although that is still the usual application of the process—but lapping is also used for many other operations, a typical example being the final sizing of die-casting dies. To show the many improvements in lapping practice during the past few years, MACHINERY has made a comprehensive review of this interesting practice, and the leading article in November deals with the subject from various angles. The abrasives used and the methods employed in charging laps are described, while the methods employed for lapping thread gages, snap gages, measuring wires, flat surfaces, ring gages, die-casting dies, etc., are explained in detail.

THE need for men adequately trained to fill positions as toolmakers, foremen, and superintendents is still keenly felt by our manufacturers. Under the old-fashioned type of apprenticeship training the boy was taken into the shop and advanced from department to department, getting his training in shop work from the busy foreman, and whatever points he could pick up himself from his fellow workmen. This method fails today to attract enough boys for the future needs of the machine-building industries. To meet the situation, many manufacturing concerns have developed apprenticeship systems along different lines. One, installed by the Taft-Peirce Mfg. Co., Woonsocket, R. I., is described in detail in this number of MACHINERY. This apprenticeship course or school gives the boy, in addition to the shop training, a real mechanical education, and may be looked upon, not as apprenticeship pure and simple, but as a school in which the boy acquires such fundamental knowledge of both the theoretical and practical principles underlying mechanical work that he should be able, eventually, to rise to an executive position of responsibility.

THE difficulties met with in testing gears have led to the design of numerous machines and mechanisms intended to show whether or not the finished gears meet the specifications. One of the most interesting devices for this purpose—used by one of the leading automobile manufacturers in the United States—is illustrated and described in November MACHINERY. The design of this fixture involves some very interesting principles, and experts on gear cutting and gear testing have pronounced it one of the best devices of its kind. Silence in gearing can be produced only by accuracy in the production of gearing, and accuracy can be insured only by proper testing means; hence the importance of devices of this kind.

EACH month MACHINERY has the privilege of recording one or more of the great advances in the field of metal-working machinery. The November number contains a description of an ingenious automatic machine built and developed by Mr. Frederick Muller of the Pratt & Whitney Co., for the production of formed milling cutters with helical flutes, these cutters having been given the trade-name "Curvex" milling cutters. In the past, no method had been evolved whereby formed milling cutters could be produced commercially with helical flutes. The special machinery described is the result of an exhaustive study of the conditions which must be fulfilled in order to manufacture formed milling cutters having helical flutes, and will be of great interest to both machine designers and shop men. Every day marks an advance.

Modern Lapping Practice

A Comprehensive Review Covering Recent Developments in Lapping Practice Including the Abrasives Used and Lap-charging Methods

Lapping Thread Gages, Snap Gages, Measuring Wires, Flat Surfaces, Ring Gages, Die-casting Dies, T-slots, etc.—By Edward K. Hammond

Lapping is no longer an art used and understood by only a few gage- and tool-makers; it has taken a definite place in machine shop practice, owing to the increased demand for work of the highest accuracy. One of the most common applications of lapping is in the final operation on various types of gages to obtain their exact size; but the use of laps is no longer restricted to such work. A typical application is for the final sizing of such work as die-casting dies. Therefore, a comprehensive review of this subject, covering recent developments, is an important addition to current literature on machine shop practice.

THE unusual demand for different types of precision gages for handling war work led to the development of numerous improved methods of lapping, and it is the purpose of this article to present a comprehensive review of the most improved practice in performing lapping operations. Laps may be used for increasing the inside diameter of holes or for reducing the outside diameter of cylindrical pieces to the specified size; tools of this type may also be employed on flat surfaces and on pieces of certain other shapes.

The term "lap" is used to denote a tool made of a fine grade of gray cast iron, brass, or some other fairly soft metal, which may be charged with an abrasive to grind the work down to size. Laps made of box wood or hard maple are extensively employed on certain classes of work, especially for imparting a final finish after the work has been brought to size. Various abrasive materials are used for charging laps, among which the aluminous oxide abrasives, alundum, made by the Norton Co., Worcester, Mass., and aloxite, made by the Carborundum Co. of Niagara Falls, N. Y., find the most general application for lapping when rapid cutting is required. Laps charged with diamond dust are also used for this purpose, while emery is the most generally used abrasive for charging laps that are used for imparting a final finish where a high polish is desired.

The form of the lap varies according to the work on which it is to be used. For instance, a lap for increasing the inside diameter of a hole will be of cylindrical form, while a lap for reducing the outside diameter of a cylindrical piece to the required size will have a hole into which the work is inserted. In either case, about 0.002 inch must be allowed on the diameter of the lap to form a clearance space for the abrasive material, which projects out from the surface of the lap.

In order to understand the way in which a lapping operation is performed, it should be borne in mind that the lap is made of soft metal, while the piece to be lapped is usually made of hardened steel. The abrasive will always embed itself in the softer metal, so that the harder the material to be lapped the harder the metal from which the lap may be made. On the other hand, the harder material will often be charged to a certain extent, unless the lap is very soft. For this reason lead and wood are often used in making finishing laps, as they tend to "uncharge" the lapped surface and produce a high polish on the work. On the more accurate grades of work, the harder laps are only used for rough-lapping.

The lapping abrasive is mixed with oil, equal parts of kerosene and lard oil being one mixture that gives satisfactory results. The abrasive and oil are mixed together and then applied to the surface of the lap; and the abrasive gradually becomes embedded in the lap until its entire working surface is completely charged. Either the work or the lap (according to conditions) must be rotated at a number of revolutions per minute which will give a surface speed of approximately 5000 feet per minute. At lower speeds, it is found that an abrasive material will not give satisfactory service in cutting hardened steel. Experience enables the operator to develop a very fine sense of touch, and this faculty is an absolute necessity, because it must be borne in mind that the lapping operation is depended upon to remove a very small fraction of a thousandth of an inch from the diameter of the work, so that the operator must learn to determine where the very slight high spots are located, and continue the lapping at such points until a uniform result is secured

Lapping Fortney "Mini-plug" Gages

The name "mini-plug" has been applied to plug gages made by the Fortney Mfg. Co., 120 Malone Ave., Belleville, N. J., owing to the extremely small sizes in which these tools are made. The range runs from 0.007 inch up to 1.000 inch in diameter, and the gages are guaranteed to be accurate within 0.00005 inch. To produce tools of this type within such close limits of accuracy, means that the greatest care must be taken in lapping the work during the process of manufacture. The gages are first reduced to within from 0.0005 inch to 0.00075 inch over size, according to the diameter of the work. A pair of aloxite oilstones is used for this purpose, between which the work is rubbed while it is rotated by power; in using comparatively new stones, powdered aloxite and oil will be found to aid their cutting action.

When the micrometer indicates that the work has been brought down close enough to the required size, the lapping operation is started. The gage is chucked in a horizontal spindle machine of the form shown in Fig. 1, and a lap charged with No. 65A aloxite is moved back and forth along the length of the surface to be finished. The machines used for performing these lapping operations are of quite simple construction. They are made of electric motors for sewing machines, built by the Hamilton-Beach Mfg. Co., of Racine, Wis., which have a foot-pedal control for the switch. In equipping these machines for lapping, the driving pulley was removed and a drill chuck mounted on the armature spindle in its place, so that either the cylindrical work or the lap may be held in this chuck, according to whether the inside diameter of the hole or the outside diameter of the work is to be lapped. The operator is able to start or stop rotation of the spindle by means of the pedal control, and the speed of rotation may be regulated within sufficiently close limits by retarding the revolution of the drill chuck with the thumb and index finger.

Fig. 1. Reducing the Outside Diameter of a "Mini-plug" Gage in a Lapping Machine

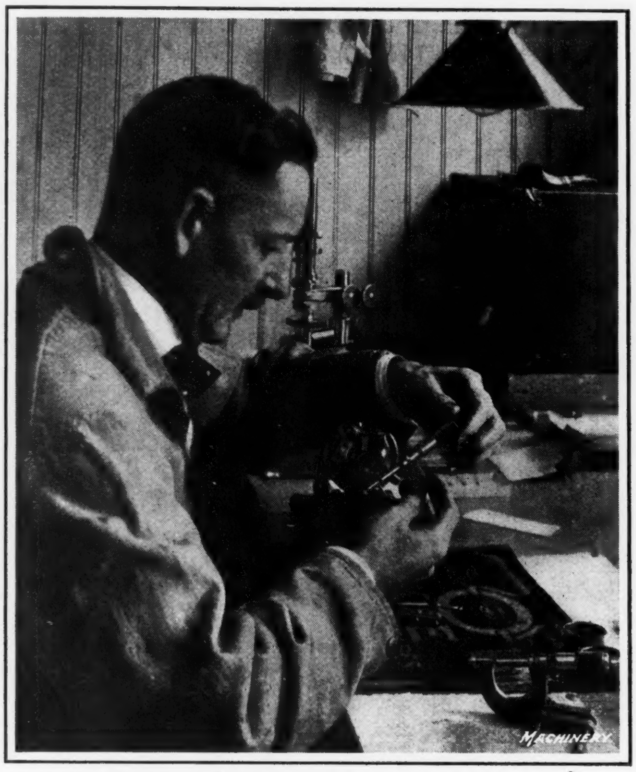


Fig. 2. Measuring Diameter to ascertain where Additional Lapping is Necessary

Making the Laps

For lapping the outside diameter of plug gages and other cylindrical-shaped work, a split lap is used, which is of the form shown at *A* and *B* in Fig. 3. It will be seen that each of these laps has four different openings to provide for lapping work of various diameters. The method of procedure in forming the openings will vary according to the diameter. For holes of considerable size, the easiest method is to clamp the two halves of the lap together, and next drill and ream the hole to slightly less than the required diameter. Then when the hardened piece of work is put between the two halves of this lap, the abrasive will start to "bite back," because the lap is softer than the work. In this way, the size of the opening will be increased; but very soon a quantity of the abrasive will become embedded all the way around the opening in the lap, and from that time on, the action will be reversed so that the abrasive material will grind down the hardened work until the required size has been reached.

The lapping operation is continued until the diameter of the work has been reduced to the specified size, as indicated with a Prestwich fluid gage, Fig. 4, which is used in conjunction with a master plug, the size of which has been verified on a Pratt & Whitney precision measuring machine. For making very small sizes of split laps, it is not feasible to drill and ream the opening. In making such tools, the method of procedure is to use a very thin saw to cut a small impression in the face of each half of the lap, and after this has been done, the work is chucked and the lap applied to it in the usual way. Owing to the back-biting action of the abrasive, to which reference has already been made, the opening in the lap will soon be rounded out to the required shape and size.

From the illustrations of split laps shown at *A* and *B* in Fig. 3, it will be seen that the two halves of the lap are held together by screws, with a nut and washer on each screw to provide for drawing the two halves of the tool inward against the work. At the time the lap is first applied to the work, the diameter of the piece that is being lapped is considerably over size and the two halves of the lap fail to come together; but as the operation approaches completion, the diameter of the work is reduced, and the nuts are accordingly tightened in order that the abrasive may be applied to the work with the necessary amount of pressure. This tightening of the screws is continued until the size of the work has been reduced as much as required. Despite the protection which the abrasive affords against the wearing of the lap, there is a tendency for the size of the opening to increase, and this is offset by occasionally removing metal from the faces of the two halves of the lap which come together at the split. After compensation has been made in this way, the lap has to again adjust itself to the work, until the opening has been brought to the proper size. It is of interest to note that when a new lap is first used, it does not cut very freely, because the abrasive has not become embedded in the lap. While the abrasive is being carried around by the work, it has more of a cutting influence on the lap than on the piece which is being reduced to size. It is only after the abrasive has been embedded, so that it remains stationary while the work revolves, that an efficient cutting action can be expected.

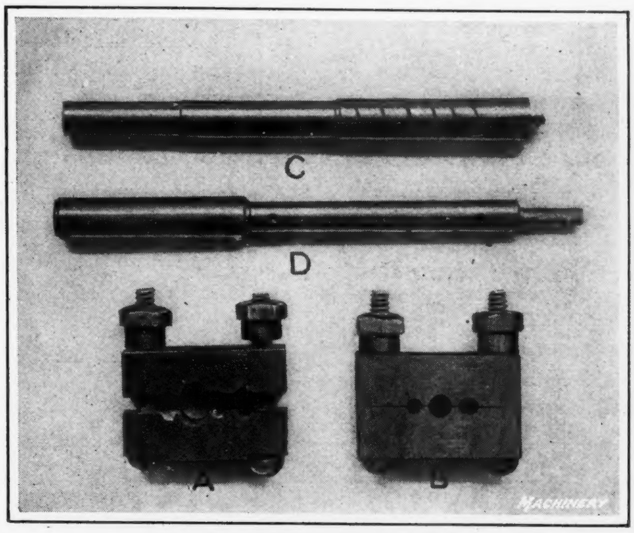


Fig. 3. (A) and (B) Outside-diameter Laps. (C) and (D) Inside-diameter Laps

Fig. 4. Checking the Accuracy of Lapped Gages by Means of Prestwich Fluid Gage

Laps for Operating in Holes

At *C* and *D* in Fig. 3, there are shown two types of laps for use in sizing the inside diameter of a ring gage, or any similar piece of work. The principle of operation of both of these laps is the same, although the result is obtained by different methods. It will be evident that the lap shown at *C* is split from the end, so that a small wedge may be driven into the split to provide for expanding the lap as the size of the opening in the work is increased. This lap is made with a spiral groove running around it, of a somewhat similar form to the oil groove in a bearing; and the function of this groove is also the same as that of a bearing oil groove, namely, to assist in distributing the emulsion of oil and abrasive over the surface of the work that is to be lapped. In making a lap of this type, care must be taken to prevent a tendency for the tool to produce a bell-mouthed opening in the work. This is done by turning the body of the lap to a taper of about 0.001 inch, with the small diameter at the open end of the split. With a lap made in this manner, driving in the tapered wedge results in expanding the lap in a way that brings it to approximately a true cylindrical form. But regardless of the amount of care that is taken in making the lap, dependence must still be placed upon the skill and experience of the man who uses the lap to bring the opening in the work accurately to size and to have it of a uniform diameter from end to end.

A certain amount of bell-mouthing is practically inevitable, as the loose abrasive tends to crowd in as the lap passes through the end of the hole; but a slight rounding of the edge is seldom objectionable, as it removes the sharp corner at the end of the hole. However, it is common practice to leave a small lip or hub at the end of a ring gage or similar piece, which is removed after the lapping operation has been completed, in order to remove the bell-mouthed end of the hole.

The lap shown at *D* is designed on the same principle as the one which has just been described, but the method of attaining the result is somewhat different. It will be seen that two transverse holes have been drilled through the body of this lap, and a very fine scroll saw is then used to cut a slot connecting these two holes. Through the end of the lap body, there is an axial hole which has been reamed to a slight taper, and by pushing a tapered pin into this hole, provision is made for expanding the lap as the size of the opening in the work is increased. With a lap of this design expansion results in making the diameter slightly larger at the center, with the size decreasing toward the two ends of the body. The departure from a truly cylindrical form is very slight, and the skill of the operator enables him to produce perfectly accurate work with such a tool. Both of the laps shown at *C* and *D* are made of brass. This material was selected because it is soft enough to become readily charged with the abrasive, and yet it is not as brittle as cast iron. If an attempt were made to produce a lap of this shape from cast iron, the torsional and bending stresses would be very likely to cause the lap to break before it had given a reasonable amount of service.

Lapping Thread Gages

After they have been machined as close as possible to the required dimensions, both male and female thread gages have to be lapped to attain the high degree of precision which is required in tools of this type. A little thought will make it apparent that the lap for working in a female thread gage will consist of a threaded plug charged with suitable abrasive, which is given a reciprocating rotary movement inside the work; similarly, the lap for reducing a male thread gage to size consists of a threaded ring which is screwed back and forth over the gage. There are various methods of applying the required oscillatory rotary movement for handling both of these classes of lapping; but one of the most convenient and efficient means provided for the purpose is a small lapping machine of the type shown in Fig. 5, which is built by the H. E. Harris Engineering Co., of Bridgeport, Conn. It consists of two pulleys loosely mounted on the spindle, which are driven

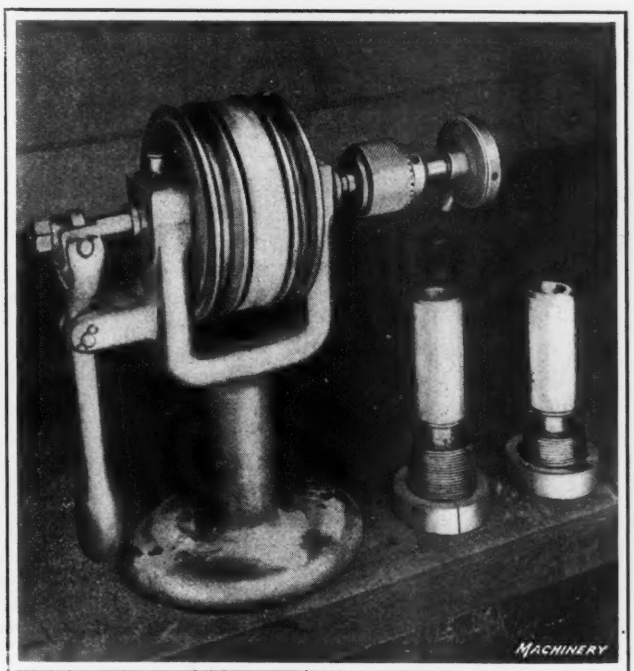


Fig. 5. Machine for lapping Thread Gages, etc.

in opposite directions by an open and a crossed belt. Between these pulleys there is a friction disk keyed to the shaft, and by means of the lever at the left-hand side of the machine, the operator is able to engage the spindle with either the forward or reverse drive.

A machine of this type can be used for lapping either male or female gages. In the former case, a drill chuck is mounted on the lapping machine spindle and the thread gage is carried by this chuck. The operator holds the clutch lever in his left hand and the lap in his right hand; then it is an easy matter, by constantly reversing the direction of rotation of the spindle, to screw the lap back and forth over the threaded portion of the gage. Exactly the same method of procedure is followed in lapping female gages, except that in this case the lap is mounted in the drill chuck and the gage is held in the operator's hand. The method of performing the operation is identical in both cases. After he has attained the necessary experience and dexterity in using a machine of this kind, the operator will be able to concentrate the action of the lap on that portion of the gage which must be reduced in size, without lapping down adjacent threads which have already been brought to the required dimensions. The machine is mounted on the work-bench at about 8 inches from the forward edge, so that an arm rest is provided on which the workman can support his elbows. In work such as thread gage lapping, it is very important to eliminate the fatigue factor as far as possible, because the results obtained are largely dependent upon the workman's sense of touch, and this will become dulled during the late hours of the day, if he becomes unduly fatigued.

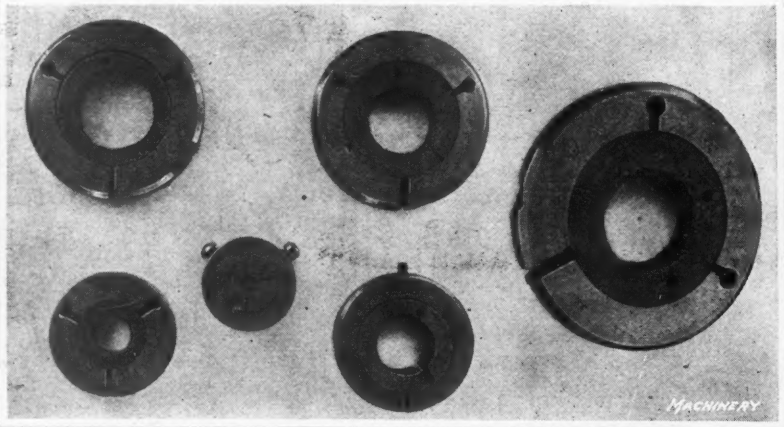


Fig. 6. Thread Gage Laps, showing Split Construction of Lap and Holder to afford Adjustment

Design of Thread Gage Laps

There is considerable diversity of practice both in making the laps and in selecting the types of abrasives with which they are charged. A brief consideration of this point might lead one to the conclusion that it is strange for two men engaged in lapping thread gages of precisely the same design, and made of the same kind of steel, to be able to attain equally satisfactory results with laps made of different materials and charged with quite different abrasives; but after giving the subject more mature consideration, the reason for such a situation will not be difficult to discover. Obviously, in the performance of an operation like lapping, the personal equation plays an important role, and as one man's sense of touch and method of procedure in doing his work is likely to differ considerably from that of the man working next to him, it is entirely conceivable that differences of practice, both in selecting materials for making the laps and in the choice of abrasives for charging them, may be the means of offsetting such differences of temperament among men employed in the lapping department. During the war, when the H. E. Harris Engineering Co. was engaged in the manufacture of thread gages, it was found good practice to provide each experienced operator with the kind of laps and abrasive materials for which he expressed a preference, and this was particularly true in the case of men who acquired their early training in other plants.

Materials Used in Making Thread Gage Laps

Various materials may be successfully employed for making thread gage laps, some of those which are most commonly used being machine steel, gray cast iron, copper, and brass. As previously stated, laps for operation in female thread gages are plain threaded plugs. Owing to the desirability of providing means of adjustment, laps for use on male thread gages are of slightly different design. Reference to Fig. 6, which shows a number of these tools, will make it apparent that the lap consists of a threaded ring which is split clear through in one place and partially split in two other positions at 120 degrees from the first one. This lap is placed inside of a holder which is similarly split and provided with clamping screws that can be tightened to compress the holder on the outside of the lap, thus causing it to contract sufficiently to compensate for wear. In the case of small sized laps, instead of having the holder split, a practice is made of placing radial screws in the holder, which can be tightened up on the lap ring to produce the same compressive effect that is produced by a different arrangement of clamping screws used on larger sized holders. Adjustment provided in the lap affords a means of regulating its size so that an experienced mechanic is able to tell by the "feel" whether the tool is cutting properly. No attempt is made to obtain any definite relationship between the size of the lap and the finished size of the work, as wear of the tool and breaking down of the abrasive on its surface would make such a condition of only temporary duration. All sizes of holders are knurled on the outside in order to provide a firm grip for the operator.

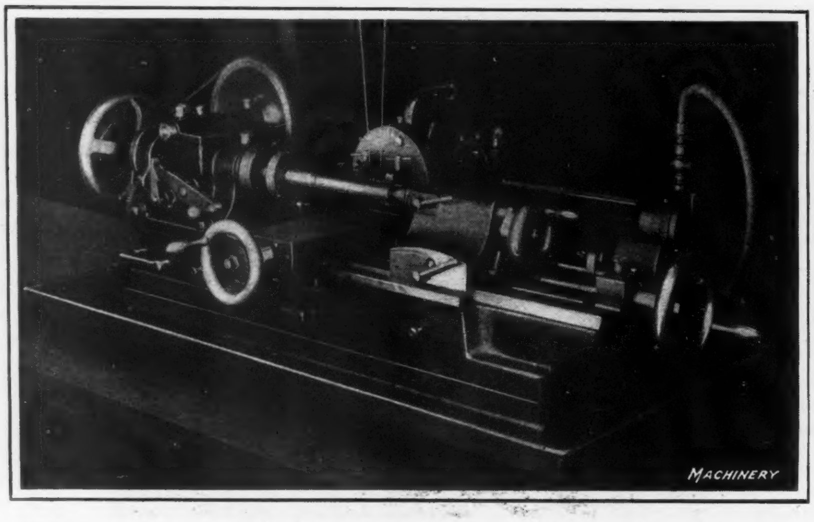


Fig. 7. Precision Lathe equipped with Thread-milling Attachment which is utilized for lapping with a Rotary Lap

Abrasives for Charging the Laps

For average conditions of operation it will probably be found that a machine steel lap will give the most favorable results, and it can be charged with either fine diamond dust, carborundum, flour of emery, flour of rouge, or flour of crocus. In any case it is important for the abrasive to be reduced to an impalpable powder which is mixed with oil before

using. Some men of wide experience in lapping do not depend upon the fineness of commercial abrasives without subjecting them to a special refining treatment. One good way of preparing the abrasive is to mix it with kerosene oil until the emulsion so produced has about the consistency of milk. After shaking, any coarse particles will settle to the bottom more rapidly than the finer ones; and by allowing the emulsion to stand for a sufficient length of time for the abrasive to settle to the bottom, the fluid can be decanted off. Care is taken to use only a portion of the abrasive taken from the upper layer. In line with the policy of allowing operators to express their preferences for a given type of lap, the H. E. Harris Engineering Co. found that it was also desirable to have each man prepare his own abrasive in order that he might make it of exactly the degree of coarseness with which he had grown familiar.

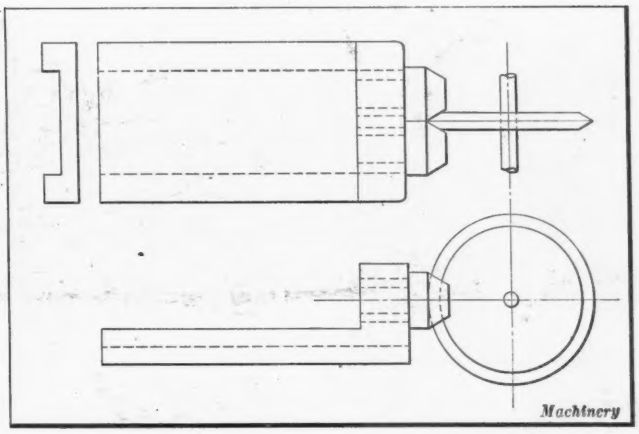


Fig. 8. Fixture for charging Rotary Laps of the Type used on the Machine shown in Fig. 7

Rotary Laps for Small Work

Lapping is a modification of the process of grinding, and in order to obtain efficient results, it is necessary for the abrasive material to be passed over the surface of the work at a suitable cutting speed. On small sizes of thread gages, it may be found that the surface to be lapped is so close to the center of the rotation that difficulty is experienced in attaining the necessary surface speed for the lap to provide an efficient cutting action. To overcome this difficulty, the H. E. Harris Engineering Co. adopted the use of rotary laps so that the work and the lap could be revolved in opposite directions, thus greatly increasing the so-called "surface" speed between the abrasive and the work. The lap used for this purpose is a steel disk with its edge formed to fit into the thread of the gage to be lapped. To use a tool of this type, it is necessary to impart a longitudinal feed movement to the lap, as well as to rotate both the lap and the work, so that the lap may follow the thread which it is desired to reduce to size. As in other cases of thread gage lapping, a reciprocating movement is employed so that the lap passes continuously back and forth over the threaded surface of the work while the operation is being performed.

A precision lathe equipped with a thread milling attachment is utilized for this purpose, the machine being shown in Fig. 7 set up for the performance of a lapping operation. The equipment used on the machine is entirely similar to that employed for thread milling, except that the lapping spindle is provided with a pulley carrying a belt running up to a large driving pulley on the overhead works, to impart the necessary speed of rotation, which is very much higher than that utilized in thread milling. Special means must be provided for charging a lap of this kind. The tool used for this purpose is shown in Fig. 8, and consists of an arm which carries two bevel-faced wheels that are so formed and mounted that the two faces of the wheels bear against the lapping surfaces of the steel disk. The abrasive generally used on a lap of this kind consists of diamond dust which is prepared according to instructions that will be given in a later section of this article.

In some shops lapping with diamond dust has fallen into disrepute, because the greater cost of the abrasive did not seem to be justified by the results obtained, either in the speed of cutting or in the perfection of finish. Primarily, this has been due to the fact that an attempt was made to force the lap to cut too fast. In order to obtain the best results with diamond laps, very light cuts and high speeds should be used. Diamond dust is not supposed to be broken down in cutting, as is the case with other abrasives; it does not break down readily, and the result of crowding the work is to dull the cutting edges of the diamond chips. An example similar to this difference between diamond dust and other abrasives is seen in grinding wheel-truing devices. A diamond wheel-truing tool depends upon its sharp cutting edge, while an abrasive truing wheel is supposed to break down while truing and thus present new sharp edges to the grinding wheel that is being dressed.

Pratt & Whitney Co.'s Practice in Lapping Thread Gages

At the Pratt & Whitney Co.'s plant in Hartford, Conn., the methods used for lapping thread gages are similar to those which have already been described so that further

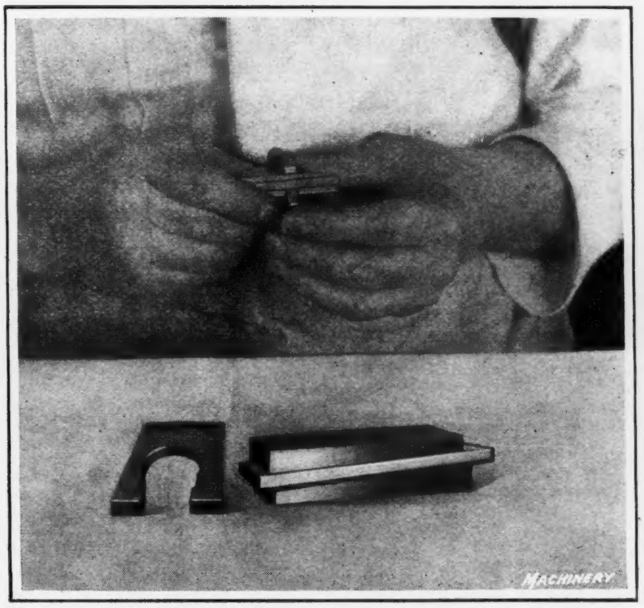


Fig. 9. Adjustable Parallel Lap used for lapping Pratt & Whitney Snap Gages

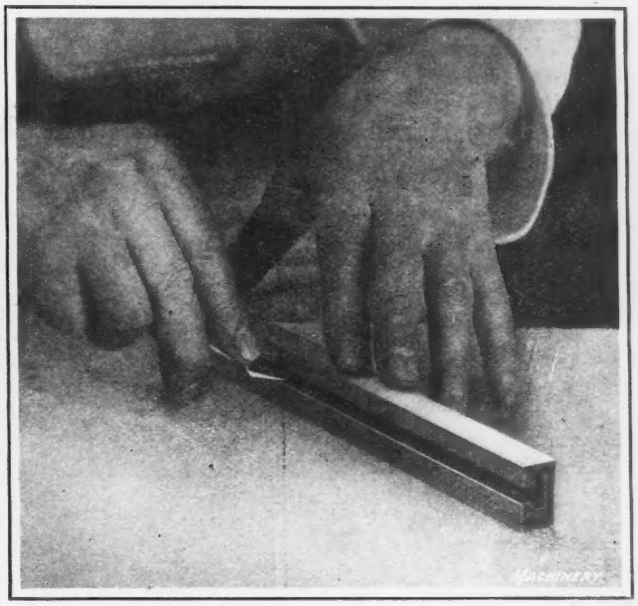


Fig. 10. Use of Local-action Lap for finishing the Vertical Walls of a T-slot

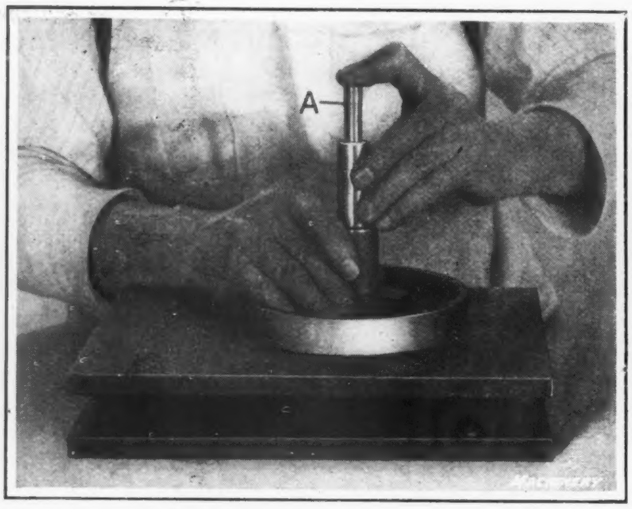


Fig. 11. Surface Lap and Fixture for facing End of Gage A Perpendicular to its Axis

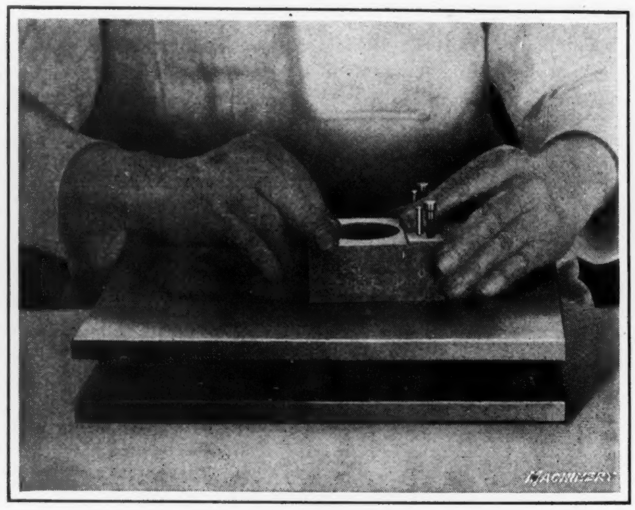


Fig. 12. Use of a Surface Lap for reducing a Large Flat Surface to the Required Condition

details are unnecessary. However, it will be of interest to note that this company has found that the best results are obtained with laps made of cold-rolled steel or machine steel, the former material being preferable, because it is softer and easier to charge with abrasive. The tool-rooms of this plant have tried to use laps made of cast iron, but for thread gages little success has been attained because of the difficulty experienced in obtaining full threads that will stand up without a tendency to flake off and wear with undue rapidity at the tops of the threads. In this plant it is a practice to perform the thread gage lapping operations at two steps, a roughing cut being taken with a lap charged with a No. 2 F or 3 F carborundum mixed with a sufficient quantity of kerosene to form a fluid of about the consistency of cream. After this preliminary lapping operation has been performed, a finishing cut is taken, using a lap charged with No. 4 F Turkish flour of emery, or No. 65 F alundum, either of these abrasive materials being mixed with sperm oil or lard oil.

Testing the Accuracy of a Lapped Thread Gage

It is not within the province of this article to enter into a discussion of methods of measuring internal and external threaded work. Such methods have recently received considerable attention in the technical press. However, in passing, it may be mentioned that any recognized method of measuring is utilized, such as the three-wire system supplemented by a Prestwich fluid gage, to test the dimensions of the gage as the lapping operation proceeds, not only with a view to ascertaining when the work has been reduced to the required size, but also to find variations at different positions on the work, in order that the lapping action may be concentrated at the high points to provide for reducing the gage uniformly to the required dimensions.

Lapping Pratt & Whitney Snap Gages

For lapping the measuring surfaces of snap gages, the Pratt & Whitney Co. makes use of an adjustable form of lap which not only has sufficient compensation so that the same lap can be utilized for finishing the surfaces on gages of a number of different sizes, but the compensation that is afforded also enables the lap to be adjusted to take up the very slight amount of wear that develops as a result of constant use. As shown in Fig. 9 it will be seen that these laps consist of two wedge-shaped members, with the inclined faces of the wedges opposed to each other. The lapping surfaces are on the outside and adjustment is obtained by sliding the two members of the lap relative to each other, so that the thickness may be increased or diminished to give the required distance between the lapping surfaces of the tool and the lapped faces on the work. After the lap has been set, it is secured in place through the use of C-clamps.

Fig. 13. Another Type of Local-action Lap used for finishing the Parallel Sides of a Bar

In cases where a greater degree of adjustment is required than that which is furnished by the inclined faces of the lap, such a result is accomplished by the use of shims or a filler block of the proper thickness, which is introduced between the inclined faces of the two halves of the lap; but it will be obvious that great care must be taken to have the shims or filler block of a high degree of parallelism, in order to avoid interfering with the accuracy of the tool. In handling this work, it is the practice to take a roughing and a finishing cut, the preliminary operation being performed with laps charged with 2 F carborundum, while the finishing operation is performed with laps charged with 4 F Turkish flour of emery. These wedge-shaped laps are made of cast iron, which experience has shown to be the best material for making laps for use on flat surfaces of considerable size.

The reason for dividing the operation up into two steps is to avoid the introduction of errors resulting from the tendency of the work to expand slightly while the roughing cut is being taken. By allowing sufficient time for the work to return to a normal temperature and size before taking the finishing cut, there is little chance of introducing an error, because the rise of temperature and expansion of the work while taking the light finishing cut are practically negligible factors. This practice of removing the bulk of the metal by a preliminary operation, and then taking a very fine cut while lapping the work to its final size, should be followed in all cases of internal lapping where the maximum degree of accuracy is required.

Surface Plate Laps

For lapping down surfaces of considerable area, use is made of what is known as a "surface plate" type of lap which consists essentially of the cast-iron surface plate

with a charge of abrasive material that affords the required cutting action on a piece of work that is rubbed over the surface of such a tool. A description of the use of a large lap of this kind would be incomplete without emphasizing the fact that it is of the utmost importance to employ an irregular movement in rubbing the work over the surface of the tool, and the reason for so doing is not difficult to understand. It will be evident that if a mechanic formed a practice of rubbing a piece of work straight back and forth across the middle of the plate, a depression would soon be worn at one point, which would greatly impair the accuracy of the work.

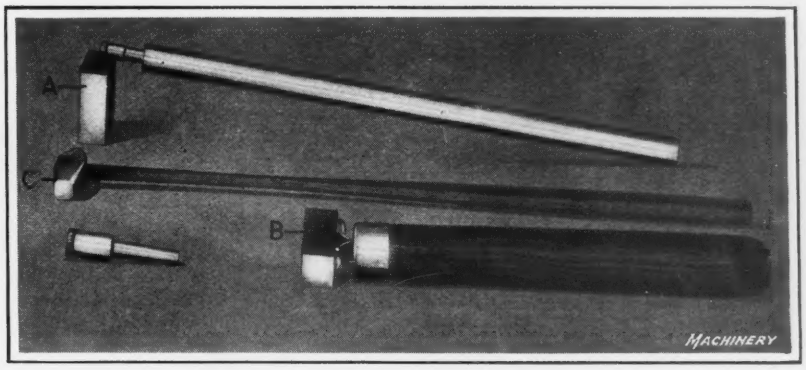


Fig. 14. Tools used for charging Laps with Diamond Dust

Probably two of the widest extremes in the range of work on which it may be required to perform a lapping operation are seen in the case of large pieces that are rubbed down on a surface plate and in the case of pieces of work with small grooves, etc., in which it may be necessary to lap down small sized surfaces to a high degree of accuracy. For the performance of these local lapping operations, use is made of what is known in the Pratt & Whitney tool-rooms as a "pencil" type of lap, which is made of a bar of copper about the size of an ordinary lead pencil, one end of the bar being flattened and bent over so that it lies in a horizontal position as shown in Fig. 10, when the lap is inclined in about the same way as a lead pencil would be while writing. There is little difference in practice in charging laps, regardless of their shape or size, but it is the general rule to take two cuts, the first of which is done with a lap charged with a No. 2 F carborundum, while the finishing cut is accomplished by using a lap charged with No. 4 F Turkish flour of emery.

It is the practice to mix the abrasive either with lard oil or sperm oil, and the men employed to perform lapping operations have small dishes of the oil and abrasives on their work-benches, into which they can dip with a small steel spatula and bring out a sufficient quantity of oil and abrasive to apply to the rotating lap. Experience has shown that it is also beneficial to occasionally apply a few drops of kerosene or gasoline to the lap, to afford a result somewhat similar to that of a cutting lubricant on a piece of work handled by a machine tool, the theory being that the kerosene or gasoline tends to wash away the very fine chips of metal that are abraded from the surface of the work by the lap.

The Norton Co. of Worcester, Mass., has had many years of experience in recommending abrasive materials for use in charging laps, and advises 2 F and 3 F alundum flour for charging thread gage laps and for other classes of gage lapping. In some cases it will be found desirable to use a 4 F grain, and for the very finest gage lapping operations the use of 65 F alundum is advised.

Lapping Die Openings with Diamond Laps

Die-castings are used in automatic counters made by the Veeder Mfg. Co., of Hartford, Conn., and this firm not only produces the castings that are needed to supply its own requirements, but also manufactures this product for sale to other manufacturers. Men who have had experience in the die-casting industry know that the dies used for this work must be extremely accurate, and in the Veeder tool-room a practice is made of lapping certain openings in the dies with laps charged with diamond dust. By this means, it is possible to hold the dimensions of such openings within 0.00005 inch or less. In this article information has already been given in regard to the performance of various internal and external lapping operations using carborundum, alundum, flour of emery, rouge or crocus as the cutting medium that is applied to the lap. These abrasives are highly satisfactory where lapping is only depended upon to remove about 0.0005 inch of metal to reduce the work to the finished size; but in the Veeder tool-room, although the work done by laps charged with diamond dust is a true lapping operation, the term "grinding" is quite generally applied to it, because the diamond lap is used to remove an appreciable amount of stock after the grinding wheel has finished its work. This is possible because the diamond lap cuts far more rapidly and freely than a lap charged with any of the other abrasives that have been mentioned. For laps charged with some cutting medium other than diamond dust, it is usually the practice to leave from 0.0002 to 0.0005 inch to be removed by the lap, while in the case of diamond laps, owing to the rapidity with which they operate, satisfactory results can be obtained by leaving as much as 0.002 to 0.006 inch of metal for lapping.

Method of Making Diamond Laps

Various metals may be used for making laps that are to be charged with diamond dust, but at the Veeder plant the standard materials are either machine steel or copper, steel being employed in the majority of cases. In making a lap, there is nothing unusual about the machine work, which consists simply of turning up a blank of the required shape and size. This blank must then be charged with diamond dust, after which it will be known as a "lap," and the procedure in handling the charging will naturally vary in the case of laps made of copper or steel. Copper being a softer metal receives the diamond dust more easily, and hence it is merely necessary to deposit on the face of a hardened steel block, shown at *A* in Fig. 14, a small amount of the dust moistened with oil to prevent it from flying, and after placing the cylindrical surface of the lap on this diamond dust, to roll it between the block *A* and the hardened steel face *B* of a tool provided for that purpose. From the illustration it will be apparent that the rolling tool is furnished with a handle of such a size and shape that the workman may grasp it in his hand and apply sufficient pressure to force the lap down on the diamond dust; this causes it to become embedded in the surface of the lap, as the copper is softer than either the face of the block or the rolling tool.

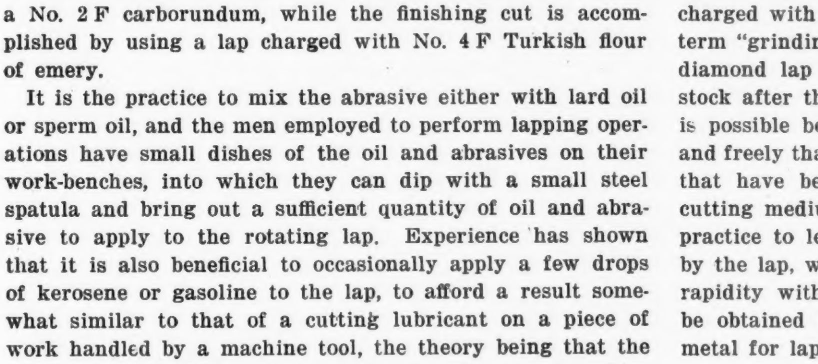


Fig. 15. Pestle, Mortar, and Hammer used in crushing Diamond Dust for Use in charging Laps

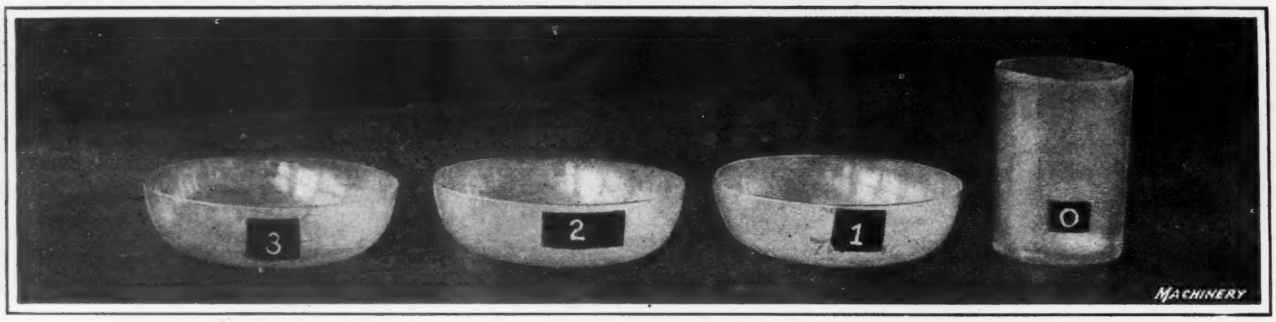


Fig. 16. Set of Glass Dishes used for "floating" Diamond Dust in Olive Oil. (The Illustration does not show the No. 4 Dish)

In charging steel laps, more trouble is likely to be experienced, owing to the greater hardness of the metal in which the diamond dust must be embedded. The charging of a steel lap is accomplished by first placing diamond dust on the face of block *A*, as previously explained, and then putting the lap on top of the diamond dust and tapping it with a small hammer *C*, the lap being turned slightly between successive blows of the hammer so that its entire face is exposed to the dust. After the work of charging has been started in this manner, the rolling tool *B* is used in the manner that has already been described, in order to provide for forcing in the particles of diamond which have already been partially embedded in the lap. A toolmaker who has not had experience in making diamond laps may ask the question: "How is one to ascertain when a lap has been thoroughly charged?" and this question would be answered by the single word "experience." However, it is noteworthy that there is very little danger of overcharging a lap, as the action of embedding the diamond dust is more or less self-compensating, that is to say, it is a very simple matter to start getting the dust to penetrate the face of the lap, but after the entire surface has been charged with abrasive, it has become so hard that the penetration of additional diamond dust is greatly retarded.

Preparing Diamond Dust for Use in Laps

Fig. 15 shows the type of pestle and mortar that is used for crushing diamonds to the degree of fineness that is required of the dust that is used for charging laps. Either white or black bortz diamonds are used for the purpose, and as this material is quite expensive, care must be taken to avoid all unnecessary losses. Two of the means used for this purpose consist of placing a few drops of olive oil in the mortar to retard the tendency of the diamond chips to fly out from under the pestle, and using a rubber washer surrounding the pestle and coming down over the top of the mortar in order to make it as difficult as possible for any chips of diamond to fly out. A little thought will make it apparent that during the process of crushing diamonds in a mortar, pieces of various sizes will be produced, and after the diamond dust has been reduced to what appears to be the required degree of fineness, it is necessary to grade it into portions containing particles of uniform sizes.

It is the practice in the Veeder tool-room to divide the diamond dust into five different grades which are designated by the numbers 0 to 4, respectively. This separation of the dust into portions of different fineness is accomplished by a process known as "floating" in olive oil. About one-half pint of oil is used to float fifty karats of diamond dust, and the separation of various portions is accomplished by decanting off the oil after allowing the particles of diamond to settle to the bottom of the container. Fig. 16 shows a set of dishes used for this purpose, and a very little thought will suffice to make it evident that owing to their greater weight, the larger particles of diamond dust will settle more rapidly than the smaller ones. The first separation is made in an ordinary drinking glass, and after the 50 karats of diamond dust have been thoroughly stirred in the olive oil, two minutes is allowed for the No. 0 particles to settle. Then the oil is decanted off into the No. 1 bowl in which three minutes' time is allowed for the No. 1 particles of diamond to settle before the oil is decanted off into the No. 2 bowl.

This process is repeated for making the three following separations, a period of ten minutes being allowed for the No. 2 sized particles to separate, twenty-five minutes for the No. 3 size, and forty minutes for the No. 4 size. Naturally the condition of the diamond dust used for charging laps will vary according to the work to be done, but at the Veeder shop practically all the lapping is done by either the No. 2 or No. 3 size. Occasionally, use is made of the No. 1 size of dust, but the majority of the particles of this size are returned to the pestle along with all of the No. 0 size so that they may be recrushed and reseparated. Similarly, most of the No. 4 size dust is too fine to be of use and so, with the exception of the very small amount which may occasionally be utilized for the finest classes of lapping, this portion of the crushed diamonds is discarded. Attention is called to the fact that in making this separation, the olive oil is never used more than once, as experience has shown that even after the No. 4 size of dust has been removed, there still is a considerable amount of residue left in the oil and if it were used repeatedly, it would become so heavily charged with this fine dust that the settling of the larger sized particles would consume a much longer time.

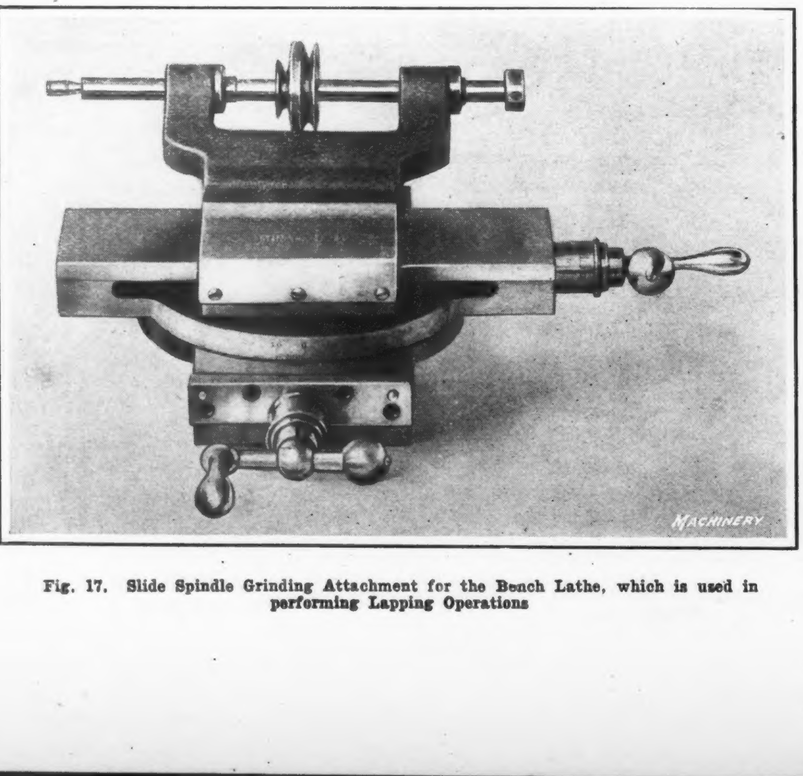


Fig. 17. Slide Spindle Grinding Attachment for the Bench Lathe, which is used in performing Lapping Operations

Precautions to Observe in Lapping Accurate Holes

In the performance of lapping operations, one of the conditions which must be carefully guarded against is to avoid having the holes formed with what is known as a "bell mouth." There are several important precautions that must be taken to avoid producing such a defect in the work, one of which is to

charge all of the diamond dust into the lap so that it is an integral part of the lapping tool, and not to apply a mixture of diamond dust and oil to the lap while it is in action. In the case of emery and other classes of abrasive, this method is permissible because the cutting action is not nearly so rapid, but in the case of diamond dust the application of a mixture of the abrasive and oil to a lap would result in piling up diamond dust at each end of the opening, as the lap is reciprocated back and forth through the hole, and thus tend to produce a more rapid cutting action at the two ends of the hole than would occur at other portions, and make the hole bell-mouthed.

Another important condition is to use a lap which has the actual working surface considerably shorter than the length of the hole to be lapped. The lapping operation is performed with the work supported by a spindle fixture on a bench lathe and the lap mounted in a slide spindle grinding attachment shown in Fig. 17. With a lap of short length, greater precision can be attained because it is easier to attain a high degree of uniformity in the cutting action of such a lap. If the length of a lap were made equal to, or even greater than, the full length of the hole, so that reciprocation of the tool was unnecessary, the variations in the charging and the consequent rapidity of cutting action would make it difficult to obtain uniform results. The use of a slide spindle grinding attachment on the bench lathe is desirable for several reasons, chief among which are the convenience with which the lap may be reciprocated back and forth through an opening in the work and the ease with which the lap may be recharged when necessary.

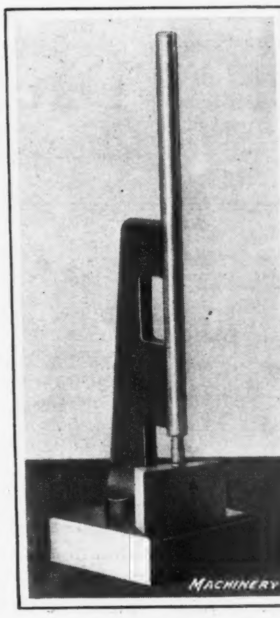


Fig. 18. Fixture for recharging Lap held in Slide Spindle

It is a matter of general knowledge that the abrasive in a grinding wheel tends to become dull or to tear out of the bonding material. Similarly, the points of the abrasive in a lap become dull or the particles pull out of their anchorage in the metal. In either case, recharging is necessary at regular intervals, and this is accomplished by following a procedure similar to that explained for charging a new lap. But in the performance of a lapping operation, it is of the utmost importance to maintain uniform alignment between the lap and the work, and if it were necessary to remove the lap from the spindle for recharging, difficulty might be experienced in resetting it in the original position. With a slide spindle attachment, however, it is only necessary to remove a collar and pull the spindle through its bearings so that the entire spindle and the lap mounted in it may be handled as a unit. Fig. 18 shows a fixture used for holding a spindle and lap while recharging the end face of the lap. Here the use of a hammer is not required because the diamond dust is placed on the hardened block *A* and the spindle is slid up and down in the vertical vees *B* of the fixture so that its weight may impart the necessary momentum to cause the diamond dust to penetrate the end face of the lap when it comes into engagement with the hardened steel block on which the diamond dust is held. When recharging a radial lap, the hammer would be used for forcing the dust in the surface, in the manner previously explained in connection with the description of charging steel laps.

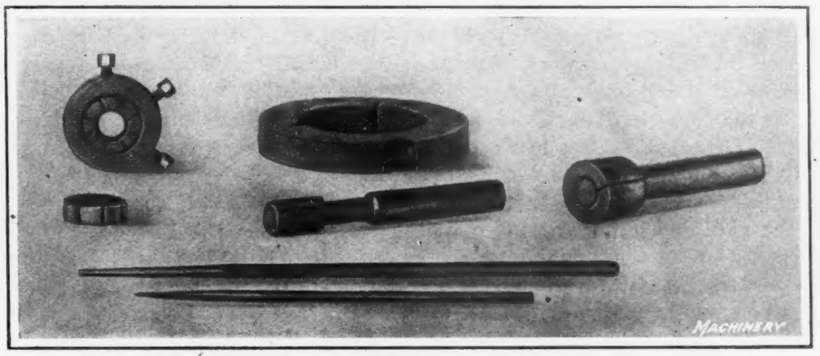


Fig. 19. Laps and Lap Holders for External and Internal Cylindrical Work

THE STEEL INDUSTRY AND THE METRIC SYSTEM

The Association of American Steel Manufacturers, which is composed of forty of the leading concerns in the steel industry and which represents 84.2 per cent of the total steel ingot capacity of the United States, has been canvassed with a view to obtaining from the different concerns their opinion as regards the compulsory adoption of the metric system in the United States. According to information given out by the Publicity Service of the American Institute of Weights and Measures, 115 Broadway, New York City, this canvass was made by the secretary of the association, J. O. Leech, in order to ascertain definitely the present attitude of the member companies on the subject. The result of the canvass was as follows: Thirty-seven companies voted against the compulsory adoption of the metric system in the United States; one company voted neutral; one voted in favor of the metric system; and one did not reply. The companies voting against the compulsory adoption of the metric system represent over 80 per cent of the total ingot capacity of the United States. The company voting neutral represents about 0.5 per cent, and the company that voted in favor of the metric system, 0.7 per cent of the total ingot capacity of the country.

It has been pointed out that a change from the English to the metric system would be especially difficult to make and very expensive if applied to the steel industry. All the standard sections are in inch sizes, and millions of dollars worth of rolls are in existence which would either have to be scrapped or changed to fit the new sizes.

* * *

IMPROVEMENTS IN RAILWAY OPERATION

Some of the railroads have made considerable improvements in the maintenance and operating conditions of their roads since the return of the railroads by the Government to their owners. The improvements that have been effected on the Pennsylvania system have been summarized in a report recently published. This report states that the number of locomotives undergoing or awaiting repairs has been reduced from a daily average of 1600, at the termination of federal control, on March 1, to 1000 at the beginning of September. The proportion of locomotives available for service has thereby been increased from 78 per cent of the total in March to 86 per cent in September. In the six months from March to August of the present year, 19,750 engines were repaired, as compared with 14,271 in the corresponding period of 1919, showing an increase of 38 per cent in the number of engines repaired. Similar improvements have taken place in the case of freight cars and in freight movement. A decided improvement has been made in the percentage of passenger trains run on time. In March, 77 per cent of the trains were on time as compared with 85 per cent in August. It is to be hoped that further improvements will take place along this line, as it should be possible to run even a greater percentage of trains on time.

Keeping Engineering Data for Future Use

By WILLIAM H. KELLOGG

A LARGE part of the time required for making up specifications and developing drawings for a job is consumed by the engineer or designer in gathering data, drawing rough sketches or lay-outs, and making calculations. After the drawings and specifications have been completed, the various sketches, preliminary drawings, and scraps of paper upon which calculations and memorandums have been made generally lie about the office until they are either forgotten, lost, or thrown away. While the greater bulk of such matter is probably of no future use, still there are nearly always some parts that would be useful on later jobs or for reference.

Many concerns have recognized the advantages obtained by preserving this material, and the writer has seen several attempts made to inaugurate systems by which data of this sort might be kept and properly recorded. The too common tendency in trying to accomplish something in this respect, is to make an inflexible system such as one involving the use of books in which computations and sketches are made. These books are kept on file after having been filled with miscellaneous matter of which only a small portion is ever used.

Kind of Information that should be Retained

Information of the kind under discussion, which might be of future use, could be readily filed in a vertical filing cabinet and recorded by means of a convenient card index. Each designer responsible for a job, or a division of one if the job is large, should be expected to compile all data consisting of important facts, sketches, memorandums sent or received in reference to the work, price sheets, quotations, photographs, clippings from catalogues, or anything that may aid in recollecting facts and ideas used in completing a job. Thus the material saved may be a scrap of paper torn from a notebook, a complete drawing, a patent specification, or a contract having some relation to the job. No designer, draftsman, or engineer connected with a job should make a sketch or calculation without including it in the available data, provided it is of sufficient value.

The writer has found that it is better to file letters pertaining to the engineering end of a job with such material rather than in the regular correspondence file under the name of the firm concerned. Some persons may not consider it so; however, the matter should depend upon the general practice of the concern involved. All correspondence belonging to the sales or other departments should, of course, be kept in the files of those departments.

Compiling Useful Information

The compilation of the data should not consist merely of collecting everything connected with a job, and so a judicious elimination of all unnecessary material should be made. No person is better fitted for this work than the designer himself. In deciding what material should be saved, questions similar to the following should be considered by the person responsible for making the decision:

"Is it likely or possible that another condition will arise in which the material can be used?"

"Is the calculation a long and tedious one, having a part or parts which might be of use in another job?"

"Are there any ingenious ideas contained which are not shown on the final drawings and which may be desired again?"

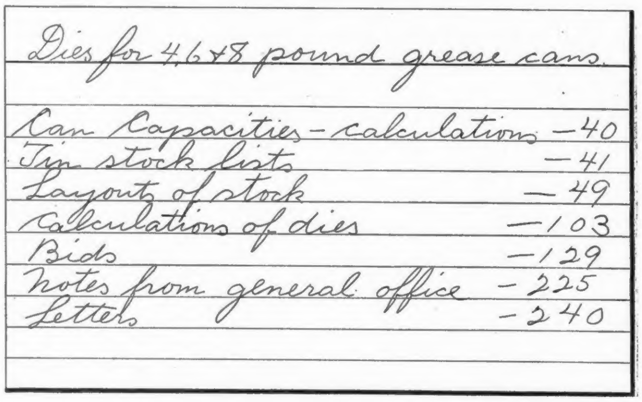
"Are any of the sketches a better portrayal of the completed job than the actual drawings?"

"Are there any statements recorded that were made by any of the persons responsible for the job which might be questioned at a future date?"

These are only a few questions among many that might be considered about any particular data.

Description of System for Filing and Indexing Material

The following system of filing the material is a simple one and consists generally of placing the data loosely in folders which are kept in the filing cabinet. These folders should be placed numerically, and the file number of a folder should be marked in a legible manner upon each piece of matter which it contains. The file number on the individual pieces of material should be marked in lead pencil or crayon so that it can be erased if desired, as one folder may become too full, and in such a case a sub-classification could be made more easily. A good way to mark each piece is to make a distinct circle upon it and place the number of the folder within this circle. The folder should be of the kind that permits serial numbering in regular order. A title should be printed on the outside of each folder telling the kind of matter the particular folder contains. It is also advisable to mark this index title with a lead pencil, and the designer may do this when he compiles the data.


Dies for 4.6+8 pound grease cans.
Can Capacities - calculations -40
Tin stock lists -41
Layout of stock -49
Calculations of dies -103
Bids -129
Notes from general office -225
Letters -240

Index Card used to record Location of Useful Data

A filing clerk may prepare the index cards and place the folders in the file; however, the index is an important part of this system, and the filing clerk should be made responsible for making the index entries accurately and completely. In many cases it will be advisable to have a heading title and a sub-title on the folder, and this will facilitate indexing. The heading title should be placed at the top of the index card, and this title should be descriptive of the job. The various data belonging to the job should be placed on the same card along with the number of the folder in which the particular data is contained. The key word of the heading title should be carefully selected, as it should be a word that will readily come to the mind of a person desiring to find some specific material.

The key word should, of course, be the first one on the index card, and these cards should be arranged alphabetically according to these words. As an example, suppose that a number of dies for producing tin grease cans are being designed. The index card prepared for this job will appear as shown in Fig. 1. All data should be filed as soon as convenient, because the sooner the material is filed the easier it will be to locate it, even while a job is still in progress. While the example shown represents a certain class of work, the system can be used on all classes.

Some of the Advantages Secured by the System

The elasticity of the system described is obvious, because the folders are placed numerically in the filing cabinet and then indexed alphabetically, either according to the job or under a general classification. When the system is new, any data can be found almost instantly, and as the amount of material becomes larger, complications are eliminated by careful cross-indexing, according to the needs. The cross-index is a time-saver when referring to the files. In regard to general classification, it will be found that the file is a handy place in which to keep such data as are used in a general way. As an explanation, some data may be useful for two or three different jobs, while others may be so general as to be applicable to almost any job. When any material becomes so general that it is constantly referred to, it should then become a part of the regular office data and be placed in the book of standard practice or posted for general reference. It should no longer be kept under this system.

It must be remembered that the system described has a different purpose from the well-known system of keeping the engineering standards of an establishment in a convenient form for reference, which usually consists of blueprints contained in loose-leaf books. It will be found, however, that this latter practice will be greatly aided and supplemented by the system being discussed. For example, machine parts that have such a similarity of design that existing patterns can be adapted for molding them can be so indexed that this fact will be known. Also, gears designed for special purposes can sometimes be used in a different application from that originally intended. Therefore, information about such gears should be readily accessible. There are, of course, numerous other machine parts which permit a general classification that will be of value.

* * *

DUTIES OF A FOREMAN IN UP-TO-DATE SHOPS

By GEORGE F. KUHNE

The foreman of today must not only have a good knowledge of the work under his supervision but must also know something about the human element. The "hire-and-fire" idea is not as common as it was, and, at the present time, a greater effort is being made to study the qualifications of each man in an organization. Psychology now plays an important part in solving employment problems. This does not necessarily imply that a man is judged by the color of his hair or eyes, but in a shop or elsewhere it means the judging of the worker's nature, aptitudes, weaknesses, etc. A foreman may say, "Oh, I haven't time for this, I'm too busy," but a good foreman will train an understudy so that more time can be devoted to a study of each man and his work.

If the best qualities of the men are to be brought out it is of first importance that each man be given the kind of work for which he is best adapted and for which he has a liking. The foreman can direct the work of his men to the best advantage only when he understands each individual. One man would resent being addressed in a certain manner, while another would not. A successful foreman will find many ways of gaining the confidence and friendship of his men. Perhaps he has a man in his department who has had trouble, such as sickness in the family; in such a case he has an opportunity to make a friend of the man by giving him advice and help. The foreman who knows his men and interests himself in their personal welfare will invariably find the workmen loyal to him as a representative of the company. This attitude on the part of the foreman will engender a cooperation in the men, and will ultimately result in increased production and benefit to both employer and employes.

It is impossible for the employment department always to place a new employe on work for which he is exactly suited. If a new man seems to be unsuited for a certain position, the foreman should make a careful study of the man's characteristics. He can then form an opinion as to what job the man can handle best and recommend that he be transferred accordingly. The foreman should become familiar, at least in a general way, with the work done in other departments, not only for his own advancement but for the mutual benefit to both employer and employes in circumstances such as those warranting the transfer of a "misfit" employe to a different department.

In summing up, let it be borne in mind that a successful foreman must study his job, his men, and each man's job. He must have a good reason for everything he says, and know just what to say and how to say it before he attempts to give instructions or orders. When this is done a "ten-league step" will be taken in the stride toward increased production. The foreman is the "balance" that weighs and adjusts differences between employer and employe; he must please both, keep on producing, and "smile."

* * *

STRENGTH OF HYDRAULIC CYLINDERS

The simple formula presented herewith for determining the thickness of hydraulic cylinders has been used satisfactorily for several years by a manufacturer of hydraulic machinery. It is known as Clark's formula for thick cylinders, and the writer believes that it deserves wider recognition among hydraulic engineers, designers, and others who have occasion to calculate the strength of cylinders.

Letting f equal the allowable stress, P the working pressure, D the outside diameter, and d the inside diameter, the formula is written

$$\frac{P}{f} = \text{hyperbolic logarithm } \frac{D}{d}$$

The solution of the following problem is given to show the application of the formula: If a cylinder having an inside diameter of 30 inches is subjected to an internal pressure of 3000 pounds per square inch, find the required thickness of cylinder, allowing a working stress of 8000 pounds per square inch.

Now according to the formula,

$$\frac{3000}{8000} = 0.375 = \text{hyperbolic logarithm of } \frac{D}{d}$$

On page 124 of MACHINERY'S HANDBOOK, 0.375 is given as the nearest hyperbolic logarithm of 1.45. Then

$$\frac{D}{d} = 1.45 \text{ or } D = 1.45 \times d$$

Therefore

$$D = 1.45 \times 30 = 43.5 \text{ inches}$$

which is the outside diameter of the cylinder. The thickness of the cylinder equals $\frac{43.5 - 30}{2} = 6.75$ inches

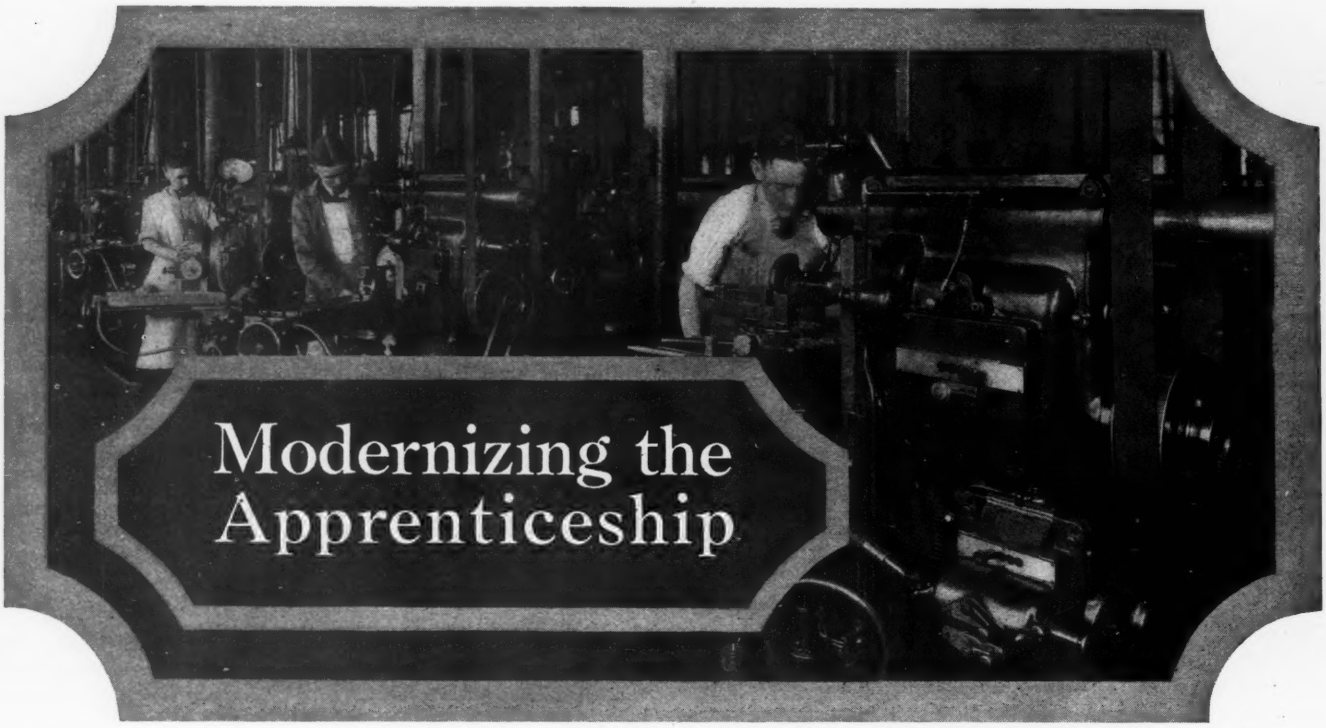
If the result thus obtained is compared with that obtained by Lamé's formula it will be found that Clark's formula gives a slightly thinner wall for the cylinder. It is generally acknowledged that Barlow's formula gives a thickness which is too liberal for ordinary purposes. As a check, using Lamé's formula for the given conditions,

$$f = 3000 \times \frac{21.75^2 + 15^2}{21.75^2 - 15^2} = 8400 \text{ pounds per square inch}$$

This stress of 8400, compared with the specified stress of 8000 pounds per square inch, shows that Lamé's formula suggests the use of a slightly thicker cylinder wall. Using Barlow's formula:

$$f = \frac{43.5 \times 3000}{2 \times 6.75} = 9660 \text{ pounds per square inch}$$

From this it will be seen that Barlow's formula gives a thicker cylinder wall than that suggested by either Lamé's or Clark's formula. W. B. G.



Modernizing the Apprenticeship

A Review of the Methods Used by the Taft-Peirce Mfg. Co., Woonsocket, R. I., in the Training of Apprentices Along Broad, Comprehensive Lines, Intended to Ultimately Fit them for Important Positions in the Mechanical Industries

By ERIK OBERG

THE old-fashioned kind of apprenticeship where the boy was merely taken into a shop and advanced from department to department, obtaining his training in shop work from instructions by the foreman and from what he could pick up from his fellow workmen, fails today to attract enough boys to supply our future needs for skilled mechanics. It is so easy today for a boy to go into a machine shop and earn good wages in operating a manufacturing type of machine tool that something more must be given him during his apprenticeship than mere shop training in order to attract him and hold him for a four-year apprenticeship, even at the much higher rates of apprenticeship wages that are paid today. This condition has been recognized by many manufacturing concerns and the details have been worked out in different ways according to the ideas of those having this matter in charge.

The Taft-Peirce Mfg. Co., Woonsocket, R. I., has developed an apprenticeship system along modern lines that gives the

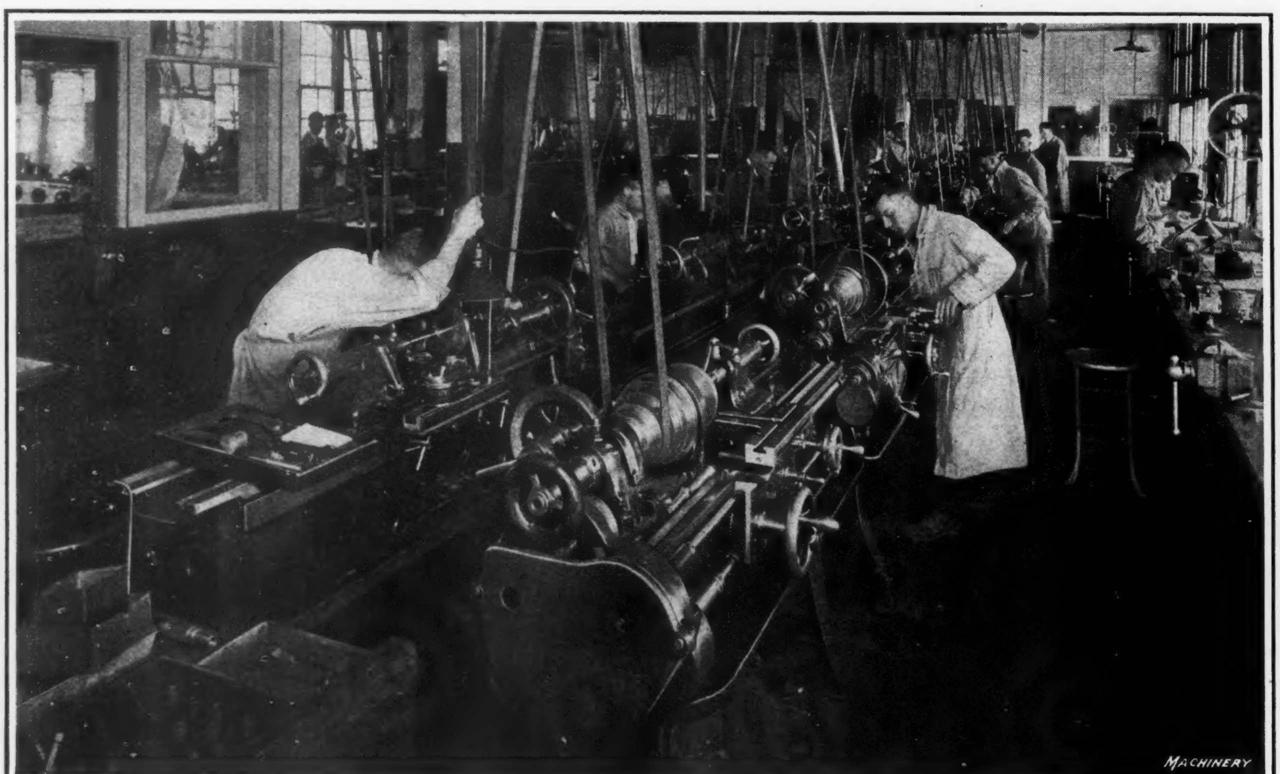


Fig. 1. Apprentices at Work in Lathe Department

Fig. 2. Apprentice grinding Gage Blanks in Taft-Peirce Plant

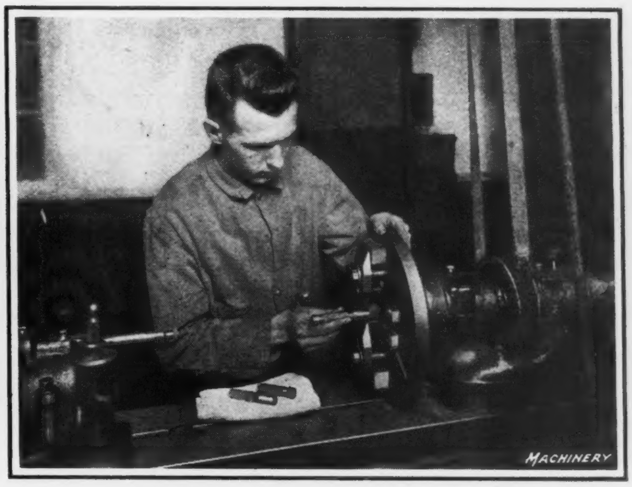


Fig. 3. Advanced Training in Tool-room Work

boy, in addition to his shop training, a liberal mechanical education, and the apprenticeship course may be looked upon not as an apprenticeship pure and simple, but as a school where a boy may acquire such fundamental knowledge of both the theoretical and practical principles that underly mechanical work, that he will be able in the future to rise to executive positions of responsibility in the mechanical trades.

Recognizing the fact that in these days a college education and often even a high-school education for a boy is beyond the financial limitations of the average parent, the Taft-Peirce Mfg. Co. has instituted an apprenticeship whereby any ambitious boy may acquire a comprehensive knowledge in those subjects that have special application to the mechanical trades, and have provided the opportunity for the boy to acquire this knowledge in the working hours during the four years of his apprenticeship. On account of the exceptionally varied line of manufacture in which the company is engaged, it is possible to give the apprentice a thorough and comprehensive training in practical shop work; but in addition to this, instruction is also given in such subjects as mathematics, mechanical drawing, shop management and industrial economics, together with the elements of chemistry and physics. The apprentice system is organized on this broad plan in order to make it possible, not merely to "grind out" toolmakers and machinists, but to qualify the apprentices that have the proper characteristics to ultimately become foremen, superintendents or designers.

The course is so arranged and handled that the boy need not possess more than average ability in addition to willingness to work to reach the goal thus defined. In addition to the desirable features involved in the training course itself, the hourly rates paid to the apprentice during the four-year course are such that he receives a substantial mechanical education while being paid wages which enable him to support himself by his work. It is the object of this article to describe in detail the manner in which this apprentice course is conducted in order that it may serve as a guidance in other plants where similar courses are contemplated.

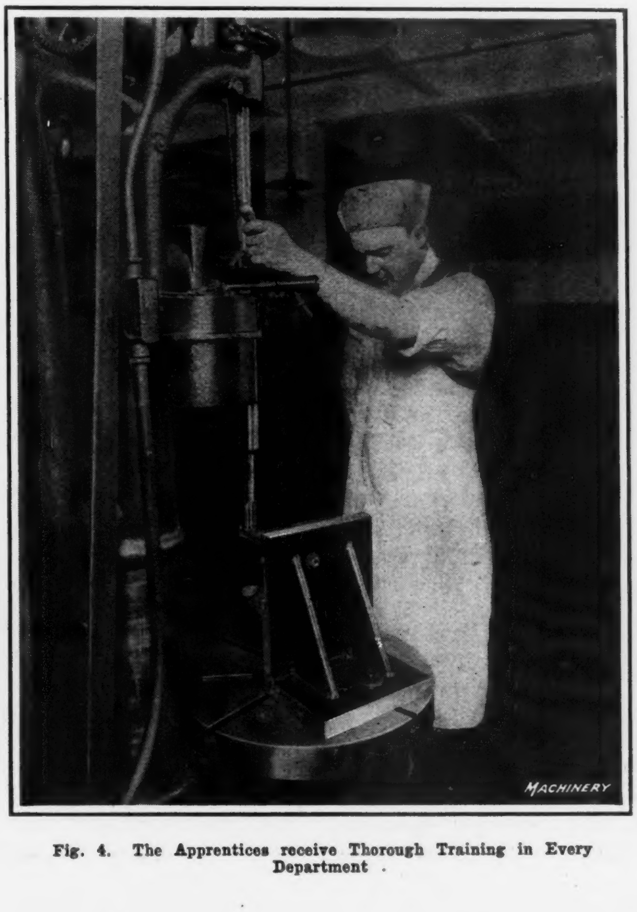


Fig. 4. The Apprentices receive Thorough Training in Every Department

General Principles of the Taft-Peirce Apprenticeship School

The apprenticeship at the Taft-Peirce Mfg. Co. is known as an apprenticeship school and is conducted very largely along the lines of a modern educational institution, with reports and records that make it possible to thoroughly check up the progress of the boy at any time during the apprentice course. The course covers a period of four years and, owing to the business of the company, is, of course, principally confined to the machinist's and toolmaker's trade, although in some instances a drafting-room course is also included. During their apprenticeships the boys are in charge of the supervisor of apprentices, C. K. Gurney, who, with an assistant, supervises the boy's work both in the shop and in the instruction room, keeps the records showing his progress, takes care of his transfer from department to department, and acts not only as an instructor in the school and shop work but also interests himself in all the affairs of the apprentice both inside and outside the works. One of the supervisor's duties is to give instructions in safe methods of working, and he is constantly on the lookout for the welfare of the apprentice during the years that the boy is in his charge.

Entrance Requirements to Apprentice Course

In order to be permitted to enter the apprentice course, the boy must be not less than 16 nor more than 19 years of age and must have a sufficient physical development to fit him for the machinist's trade and must have good eyesight and hearing. A boy is expected to have completed grammar school and should be mechanically inclined, as he cannot be successful unless he has a natural bent for mechanical matters. Generally, boys who smoke cigarettes or those who want to go to work merely in order to escape going to school are not accepted. A special application card has to be filled out giving the following information relating to the applicant: Name; address; name of parent or guardian,

APPRENTICE ROUTING RECORD
THE TAFT-PEIRCE MFG. CO.

NAME
NUMBER

DEPARTMENTS	WEEKS	TRIAL PERIOD	1ST YEAR	2ND YEAR	3RD YEAR	4TH YEAR	FOREMAN	DATES FROM	DATES TO	WORKMANSHIP	CONDUCT	INDUSTRY	CLASS ROOM	ATTENDANCE	TIME LOST	TIME MADE UP
Errands																
Blacksmith or Stock Room																
Tool Crib																
Lathe																
Scraping																
Drilling																
Milling																
Gear Cutting, etc.																
Planing																
Cylindrical Grinding																
Surface Grinding																
Assembly-Repairs																
Tool Dept.-Lathe																
Tool Dept.-Milling																
Tool Dept.-Jig-Boring																
Tool Dept.-Assembly & Misc.																
Punch & Die Work																
TOTAL																

Fig. 5. Record of Apprentice's Work

with address; boy's nationality; father's nationality; mother's nationality; father's occupation; boy's age, height and weight; whether using pipe, cigar, cigarette or chewing; whether living at home or boarding; where employed at present and by whom; previous employment; grammar school attended, date of graduation or grade finished; high school attended, date of graduation or grade finished; questions relating to health, such as whether the boy has any organic diseases, rupture or deficiency of sight and hearing, adenoids, etc.; reason for selecting this trade; and a note made by the interviewer as to the general appearance of the boy. Space is also provided for names of references.

After the boy has qualified through his answers to the questions on the application card and by the general impressions of the interviewer, he is usually required to take an examination in simple mathematics, including fractions, percentage, decimals, ratio and proportion, square root, mensuration, etc. In case of a high-school graduate, this examination is omitted. Should the number of applicants be unusually great, competitive examinations will be held.

After having been accepted for the apprenticeship course, the boy is placed on a three-months' trial period and is supplied with the tools necessary for his work during this three-months' trial. During this period he is paid at the rate of 22 cents per hour.

Compensation and Obligations During Apprenticeship Period

During the three months' trial period the boy is kept under close observation and if at the end of this period he is accepted for the full apprentice course, he is required to sign the apprentice agreement, to pay a fee of $25, and to purchase a set of tools at the cost of $15. The fee of $25 is required as an evidence of good faith and is intended to discourage those who only "want a job" or who wish to avoid going to school. In this way, the course is also made a more desirable one for those who have the required ambition to learn the trade thoroughly. The deposit of $25 is forfeited if the boy does not finish his term or is discharged because of violations of the rules of the apprenticeship agreement. On the other hand, if the boy completes his apprentice term in a satisfactory manner, the deposit is returned to him with an additional $125, so that he receives at the close of his apprenticeship $150 and a diploma signed by the officers of the company.

During the four years of apprenticeship the boy receives the following wages: Trial period and first year, 22 cents per hour; second year, 26 cents per hour; third year, 30 cents per hour; and fourth year, 35 cents per hour.

The Shop Course

If a boy has had no previous experience in a machine shop he is usually placed in the tool crib for the first month in order to get acquainted with the names of the various kinds of tools that are used. If he has had previous shop experience, he is started immediately on production work in the machine shop. The four years are generally divided between the manufacturing departments and the toolroom, a boy serving two years in each. The first two years are devoted to the manufacturing departments, the division of the time being about as follows: Lathe work, 8 months; milling machine work, 6 months; drill press work, 2 months; surface grinding, 2 months; cylindrical grinding, 2 months; planer work, 4 months. In the tool-room the boy is generally kept on lathe work about 6 months, on milling machine work an equal length of time, on horizontal boring machines from 3 to 4 months, and on bench work and tool assembling from 8 to 9 months.

If an opportunity arises, the boy is generally put into the repair shop for one or two months during the first two years and is also placed for a few months on assembling work. During the last half of the fourth year his work is practically that of a journeyman toolmaker.

Sometimes the boys are given their first training in the special training school for machine operators maintained by the Taft-Peirce Mfg. Co., which training school was described in the September, 1918, number of MACHINERY, with special reference to the training of women for war work. At the present time no women are trained for manufacturing work, but the training school is still being maintained for machine operators and occasionally for the first training of the apprentices. If a boy should not happen to do as well in a shop as there is reason to expect, or if he appears to need a more thorough training than that which the shop foreman has time to give to him, he may be taken temporarily, at any time during his apprenticeship period, into the training school so that he may be under the direct charge of the supervisor of apprentices.

The Apprentice School Course

The underlying principle of the instruction in the actual apprentice school is that each boy must have individual attention; hence, the classes are divided so that there are only from five to ten boys in each class, and the boys thus placed in the same class do not necessarily need to be on the same lesson, as each boy is encouraged to go ahead as fast as he can. The classes are rearranged when some boys are so far ahead of their classes that it becomes more advantageous to place them in a more advanced class, so that, as far as possible, the boys in each class may be reasonably on the same level. The school instruction for each boy consists of four hours a week, divided into two 2-hour periods, one of which is between 7 and 9 in the morning on one day, and one from 1 to 3 in the afternoon on another day. Mathematics and other subjects are taught in the morning session, and mechanical drawing in the afternoon session.

No. Name Month

	MON.	TUES.	WED.	THURS.	FRI.	SAT.	AV.
DRAWING ELEM.							
SHOP PRACTICE							
MATH.							
MACHINE DESIGN							
TOOL DESIGN							
APPLIED CHEM.							
METAL-LURGY							
SHOP SCIENCE							
						Average	

Fig. 6. Apprentice's Class-room Record

The mathematical course is a rather ambitious one and has been laid out with a view that it can be completed by the boys who show the greatest aptitude for this kind of training, while some of the others will not quite complete the course. During the first year the grammar school arithmethic is reviewed and its application to shop problems emphasized. Later, the solution of triangles, the use of formulas, and the application of mathematics to screw threads, gearing, feeds and speeds, spirals, the calculation of change-gears for screw cutting and for the cutting of spirals, and plain and differential indexing, is taught.

The mathematical problems solved by the boys in the advanced years of their apprenticeship are by no means simple. They include some of the rather complicated problems that are met by the designer of machine tools and machinery in general, such as calculations in connection with feed and reverse mechanisms; gearing center distances in cases of tumbler gears; the figuring of taper gibs for slides, etc.

In addition to the course in mathematics, an elementary course in chemistry, particularly relating to machine shop materials, elements of the metallurgy of iron and steel, shop economics, etc., is given. An important feature of the course is the teaching of the relation between labor cost and selling price, the boys being shown the different items that enter into the selling price of an article, it being explained to them that the direct labor cost is only a small item, the cost of materials, insurance, taxes, cost of buildings and machinery, upkeep of equipment, etc., add a large proportion to the final cost at which the manufactured product is finally disposed.

The drafting course consists of geometrical problems and the making of drawings from actual objects—both detail drawings and assemblies. The object of the drafting course is not to make draftsmen but to train the boy, by making drawings, in the ability to read drawings.

Sometimes a boy shows unusual aptitude for mechanical drawing and machine design while he may not show any particular talent for actual shop work. In that case, after he has finished his two years in the manufacturing departments in the shop, he may be placed in the drafting-room to finish his apprenticeship course there. In other cases, boys who show considerable inclination for drafting may be permitted to spend the first six months of the fourth year in the drafting-room, finishing their apprenticeship by another six months in the shop. This arrangement, however, is rather an exception than a rule because the purpose of the apprentice school is mainly to train shopmen who may ultimately become shop executives rather than machine designers.

Records Kept of the Progress of the Apprentice

Fig. 5 shows what is known as the "Apprentice Routing Record" which gives complete information as to the work that the apprentice has been doing during his whole time of apprenticeship, and the number of weeks that he has spent in each of the various departments of the plant. It records the dates when he entered and left the department, and the name of the foreman. In addition, space is provided for recording, by percentages, the mark received by the apprentice in each department in regard to workmanship, conduct, industry, attendance, and time lost and made up, together with a summary of his class-room record. The marking for workmanship, conduct and industry is made by the foreman in whose department the boy is working and is made out on a special form. The supervisor of apprentices generally asks for such a report from the foreman on each boy about once in two or three months. The foreman marks the workmanship, conduct, and industry by four graduations: excellent; good; fair; or poor—according to his estimate of the boy's work and conduct. The time lost is placed on the record in Fig. 5 from the time-clerk's report, which is filled out each morning and sent to the supervisor of apprentices, giving for each department the names of the boys, the number of hours that they lost, if any, and the cause, if known. The class-room record is filled in from a more detailed monthly record which is kept by the supervisor and his assistant, giving the percentage for each lesson, a blank providing for this record being used for this purpose, as shown in Fig. 6.

Every six months a semi-annual efficiency report of each boy is sent to his parent or guardian, the form for this report being shown in Fig. 7. On the back of this form, answers are also given to the following questions: Does he take hold of new work readily? Does he read drawings readily? Is he painstaking? Does he make many mistakes? Does he take good care of his machine and tools? Is he trustworthy without supervision? How does he compare with others in his class? A duplicate of this report is filed and together with the apprentice routing card (Fig. 5) constitutes a very complete record of the boy's performance; it is useful not only for use during his apprentice period, but for future reference, when the question as to his employment or promotion may be considered. On the back of the card Fig. 5 certain remarks are entered by the supervisor indicating, for example, the work for which the boy is most

SEMI-ANNUAL EFFICIENCY REPORT

of

THE TAFT-PEIRCE APPRENTICE SCHOOL.

The Taft-Peirce Manufacturing Company.

Name ....

Department ....

For six months ended 19

	Subjects	Relative Weights	Ratings
	Attendance,	1	....
	Application,	1	....
	Adaptability,	2	....
	Habits,	2	....
Ability,	Quality of work,	2	....
	Quantity of work,	2	....

Efficiency, ... %

Quality of work, ...

Quantity of work, ...

Excellent	Good	Fair	Poor
90 to 100	80 to 89	70 to 79	Below 70

Class Work ....

Total Efficiency ....

Form R R-P 15793.

Fig. 7. Report sent to Parent or Guardian

fitted, whether he shows executive ability, etc. A complete summary of the percentages for workmanship, conduct, industry, etc., is also entered on the back of the card, giving the average for each of the four years, as well as a complete average for the whole four-year course. It is evident that by such a complete record it is possible to notice immediately any deficiencies in the boy's training and to take steps in time to remedy any defects.

General Conditions Relating to the Apprentice Course

During their four years of apprenticeship the boys are strongly urged to subscribe for such journals as MACHINERY or the *American Machinist* so that they may be constantly informed as to what is going on in the mechanical world. In regard to class-room work, the boys are advised to do a certain amount of home study and reading as this is necessary in order to advance more rapidly. With a view to the boy's health and conduct, the apprentice is expected to refrain from the use of cigarettes at all times during the four-year course; the smoking of cigarettes may result in

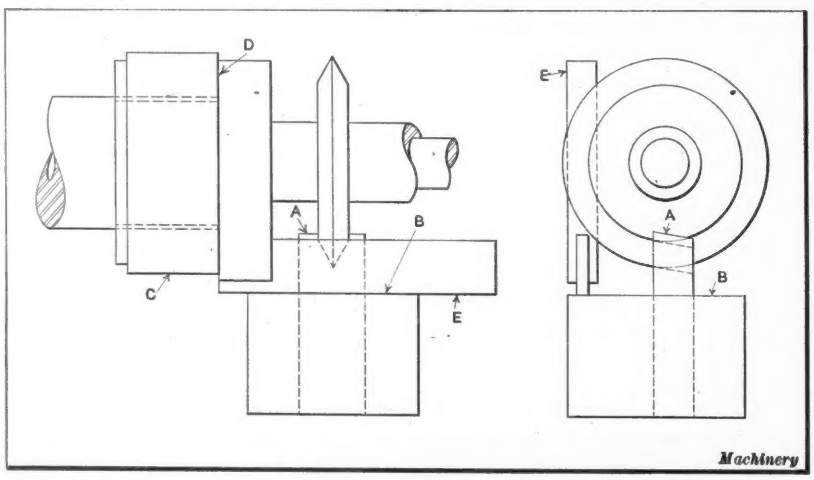
his discharge. The use of tobacco in any form is forbidden the apprentice within the premises of the plant.

It will be readily recognized that the principles upon which this apprenticeship course is based involve that which is best in the old-time plan of apprenticeship, such for example as actual work in the manufacturing departments in the plant under the direct authority of the shop foreman; while on the other hand, it introduces a number of new features aimed to provide the boy with a much broader training than was possible under the old plan. A combination of these two features, if applied on a large enough scale by all the larger manufacturing plants in the country, would tend to prevent the extreme scarcity of skilled men, and particularly the scarcity of suitable executives having the required mechanical skill, from which the industries suffer today.

* * *

SETTING A TOOL FOR TURNING SYMMETRICAL WORK

On lathes and similar machine tools, it may be required to set up a formed cutting tool in such a position that it will turn two sides of the work symmetrical with respect to a central plane that lies at right angles to the axis of centers on which the work is supported. As a case in point, consider the diagram presented in connection with the following description. Tool *A* is required to finish two inclined sides around the circumference of a disk so that they will be of the same lengths and inclined at the same angles to the central plane of the disk. The desired result is accomplished as follows: The front face *B* of the tool-block is carefully ground, and this block is then set up on a compound rest. A collar *C* on the front end of the spindle has its end *D* accurately faced with a lathe tool, after the collar has been screwed on the spindle.



Method of setting up a Formed Tool to assure having it turn Two Sides of a Piece of Work Symmetrical with Respect to a Central Plane

A steel square *E* is next utilized to test the accuracy of the tool setting. It will be apparent that with the face *D* of the collar *C* finished by a tool on the lathe, this face will be at an exact right angle to the spindle. The compound rest is next adjusted so that with the square *E* held in the position shown, a feeler made of cigarette paper cannot be withdrawn from under the square in any position along the face *B* of the tool-block or along face *D* of the collar. It will be noticed that face *B* of the tool-block is ground while face *D* of the collar is merely turned. Grinding would also be preferable for the face of the collar, but it is more important to be sure to have this face exactly perpendicular to the axis of the spindle, and the only way of being sure of obtaining such a relationship is by finishing the surface with the collar while it is in place on the spindle of the machine on which it is to be used.

* * *

According to *Reactions*, it has been found that an addition of 3 per cent of pure manganese to what is known as "railroad thermit" will materially prolong the life of thermit-welded wobblers on steel mill pinions, rolls, and large shafts. This addition of manganese produces a hard wearing surface. The wobblers must be thoroughly heated to about 1400 degrees F. before welding.

WORCESTER POLYTECHNIC SCHOLARSHIPS AWARDED BY NORTON CO.

The Norton Co., Worcester, Mass., has announced the establishment of a number of scholarships at the Worcester Polytechnic Institute. It is believed that there are many men among the employes who would be capable of assuming greater responsibility if they were able to secure a technical education which has been denied them through force of circumstances. The scholarships that will be awarded therefore. will be given to applicants who are either employes, or sons or dependents of employes, of the Norton Co., and other things being equal, length of service will be taken into consideration. The scholarships are for the benefit of men who cannot afford to pay their own tuition at the institute. Applicants must also satisfy the entrance requirements of the institute or, if they are already students there, they must be in regular standing.

The scholarships will be awarded yearly for a term of one year. For the present year there are four scholarships, but for the period of nine years from 1921 to 1930, there will be six scholarships annually, and following 1930 there will be available such a number of yearly scholarships as the trustees of the Worcester Polytechnic Institute may consider advisable considering the income from the fund set aside for this purpose. The Norton scholarships will provide for tuition and laboratory fees in any of the courses in mechanical engineering, civil engineering, electrical engineering, or chemistry given at the institute. The acceptance of applicants is made by the directors of the Norton Co., upon recommendation of the service committee and the educational director of the Norton Co., but the awards of the scholarships will be made by the trustees of the Worcester Polytechnic Institute. When conditions permit, the Norton Co. announces that it will endeavor to offer summer work to students holding scholarships in order that they may become familiar, to a certain extent, with the product of the company and its manufacture.

* * *

INVESTIGATION OF GAGE TOLERANCES

The Sectional Committee that has been appointed by the American Society of Mechanical Engineers to standardize plain gages for general engineering work is endeavoring to collect all the information possible on the subject, and to this end has sent a questionnaire to members of the society and to firms in the machine-building field.

The questionnaire asks information as to the name of the firm and the product manufactured; the extent to which gages are used; the kind of gages used; the extent to which tolerances are used on the dimensions on the drawings of the products; and the classes of fits used—running fit, push fit, drive or press fit, or shrink fit, etc. The questionnaire further requests tables of allowances and tolerances used for the various fits, or if tables or formulas cannot be furnished, that the difference in dimensions between the mating parts for the loosest fit and the tightest fit allowed in each class be stated. The questionnaire may be obtained from H. W. Bearce, secretary of the Plain Limit Gage Committee, Bureau of Standards, Washington, D. C.

Dies for Flanges and Bearing Races

By J. BINGHAM, President, The B. J. Stamping Co., Toledo, Ohio

THE die illustrated in Fig. 1 produces flanges of the type shown beneath the die, in a single operation of the punch press. The operation consists of blanking the sheet metal from which the flange is manufactured, punching a hole through the center of the blank, and drawing the flange to the desired shape. The illustration shows the die and flange at the completion of an operation. The material from which the flange is made is 1/8 inch thick, the outside diameter of the blank being 8 3/8 inches.

When punch *A* is withdrawn from the die at the end of an operation, drawing ring *B* is also raised until its upper surface coincides with that of the inner die ring *C*. This is accomplished by means of pins *D* which are actuated by a rubber buffer of the common type. The sheet-metal strip from which the blank is to be cut is laid on the upper surface of the outer die ring *E*, preparatory to the performance of an operation. Then as punch *A* descends on the downward stroke of the press ram, the blank is cut to size when the bottom edge of punch *A* passes the cutting edge of die ring *E*. The upper surface of die ring *C* is 1/8 inch, or the thickness of the blank, beneath the upper surface of die ring *E*, so that at the end of the first step in the operation, the blank rests on the top surface of die ring *C* and drawing ring *B*. The large hole is cut in the center of the blank by the central punch part *F* as the punch continues to descend, and since the bottom surface of part *F* is in the same plane as that of punch *A*, this punching step commences immediately upon the completion of the blanking.

The flange is drawn to the desired shape around die ring *C* as punch *A* continues to descend, pushing drawing ring *B* downward at the same time. The pressure between the drawing ring and the punch is sufficient to draw the blank from between die ring *C* and stripper *G*. This stripper is held on the top surface of die ring *C* on the return stroke of the press ram, by means of several expansion coil springs *H* contained in punch *A*, until the lower surface of punch *A* passes the upper surface of die ring *C*. When this occurs, the heads of the fillister-head machine screws *I* come in contact with the bottom of the counterbored holes in which they are contained and thus cause the stripper to be raised as the punch completes its return stroke. The flange is prevented from adhering to the punch as it is raised by coming in contact with the stripper. Drawing ring *B* is returned to its normal position as the punch and stripper ascend, and thus ejects the flange from the die.

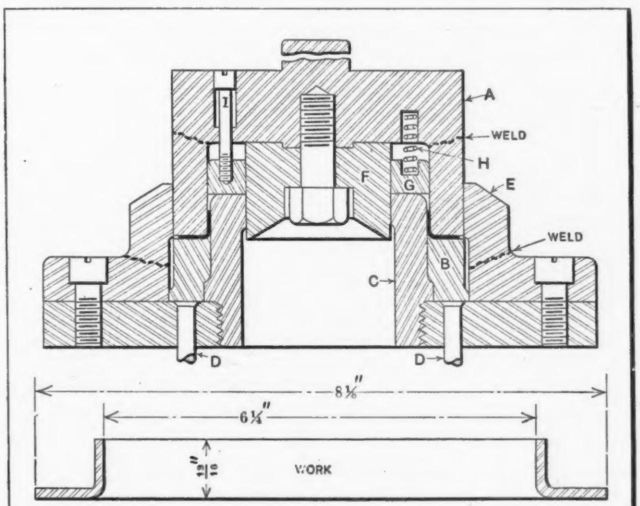


Fig. 1. Die employed in the Production of Flanges, with which Three Distinct Operations are performed

In order to effect economy and facilitate machining, the lower portion of punch *A* was made of tool steel while the upper portion was made of machine steel. These two parts are welded together at the point indicated by the heavy dotted lines. The die ring *E* was also made of two materials, the upper portion being tool steel.

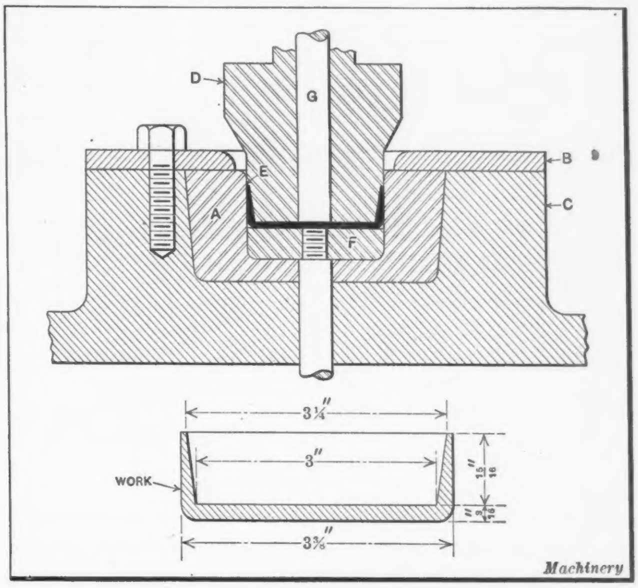


Fig. 2. Type of Punch and Die provided on Heavy-duty Punch Presses for the Manufacture of Roller Bearing Races

Die for Automobile Roller Bearing Races

Roller bearing races of various sizes for automobiles are satisfactorily produced on punch presses from steel plate ranging from 3/16 to 1/2 inch in thickness, by means of the punches and dies shown in Fig. 2. Owing to the purpose for which the parts are intended, a high grade of steel is used in the manufacture. Due to this fact, and to the thickness of the metal, a heavy-duty machine must be employed for the operation. The die illustrated is of the drawing type, and produces the shell illustrated beneath the die from blanks 3/16 inch thick and 4 inches in diameter, which are cut in a preceding operation. After the drawing operation has been performed, the closed end of the shell is blanked out on another machine, and the race hardened and ground.

In the operation performed by the punch and die illustrated, the blank is located on the drawing die *A* by means of the gage ring *B*, which serves a double purpose by also securing the drawing die in die-block *C*. The shell is formed as the blank is drawn into die *A* by punch *D*, when the punch descends on the downward stroke of the press ram. On work like this, surplus metal is provided in the blank, in this case a width of about 1/8 inch being allowed around the entire periphery. This surplus is sheared off by shoulder *E* on punch *D* as the shoulder enters die *A*, at which time sufficient metal has been drawn into the die to produce the shell. The shell is squeezed extra hard toward the end of the stroke, which causes the metal to flow up along the punch about 1/16 inch, and insures uniformity and compactness. If the shell remains in the die when the punch is withdrawn, it is ejected by means of the knock-out pad *F*. Rod *G* forces the shell from the punch in case it sticks.

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THE SMALL RAILWAY REPAIR SHOPS NEED MODERN MACHINE TOOLS

Some railroads transfer obsolete machine tools from the larger to the smaller repair shops because it is considered economical to use in the latter, machines which are no longer economical for shops handling a large volume of work. But an obsolete machine is inefficient and wasteful wherever it is, and even a small shop needs modern machines and tools—not as large a variety, but tools well designed and of high productive capacity.

As the function of both small and large repair shops is to keep locomotives in service, the powerful, rigid, conveniently controlled machine tools now used so generally in progressive machine-building plants will prove to be a good investment for railway repair shops generally, especially when compared with the light designs antedating the introduction of high-speed steel and still seen in too many railway shops. The cost of replacing these obsolete designs would be small compared to the saving effected by the use of up-to-date tool equipment. Many of these old machines have been in use more than twenty years, and some are actually considered worth shop room after even forty years of service. The continued use of such equipment means needless waste and is an indication of inefficient management, almost always on the part of financial executives. The shop executive will always buy good tools if he is allowed to.

Light cuts and slow speeds greatly decrease production, and the inaccurate work from many obsolete tools increases the time required for assembling machined parts. These old machines are also a source of discouragement to the men who must use them—a factor not to be overlooked. It is well known that locomotives are kept in repair shops longer than is necessary owing to the use of obsolete tools, and a careful study of conditions in representative repair shops shows that the loss from this source is even greater than is generally realized.

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HIGH WAGES FORCE USE OF LABOR-SAVING MACHINERY

Manufacturers of labor-saving machinery and automatic machines, even in these days of mechanical progress, often find it difficult to induce some users to replace their old equipment with modern machinery. The present high wages, however, have made it evident to users of machine tools that the automatic and semi-automatic machine possesses great cost-saving possibilities. In one factory a textile machine part manufactured in quantities was produced in an antiquated way on eight engine lathes, each being operated by a boy. When boys could be hired cheaply there was no urgent need for a change in methods, although for the last ten years, at least, there have been machines on the market which made it possible to reduce the cost of production even at the wages paid boys prior to the war. But the cost of such labor has so greatly increased that the manufacturers referred to found it urgently necessary to study cost-saving, and discovered (perhaps by reading an advertisement) a type of automatic machine capable of producing their entire output on a single machine with one operator. The manufacturers figured that by producing one part every five minutes they would save money over the methods in use; but on actual trial the machine turned out one complete part each minute, enabling them to greatly increase their output with but one machine and at a fraction of their former production expense.

Well informed mechanics everywhere are familiar with similar instances, and the question of initial outlay, which holds many down to obsolete methods, must give place to the necessity of meeting competition in production costs. High wages will therefore continue to act as a stimulus to the introduction of labor-saving machinery and automatic devices in all manufacturing industries.

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HIGH-CLASS WORK NOT ALWAYS EXPENSIVE

Some time ago a manufacturer of universal joints was told by an automobile builder who bought his product that unless the quality of the universal joints improved, there would be no further orders. The manufacturer replied that he could not possibly make the joints any better for the price paid. The automobile builder—a man of long, practical mechanical experience—answered, "I will tell you how you can make those joints better, and how in making them better, you will produce them cheaper." He then proceeded to point out how much of the money spent in the manufacture of the universal joints was wasted through a mistaken manufacturing policy—namely, the effort to reduce production costs through speeding up the work to a point where accuracy and interchangeability were sacrificed, which resulted in a large proportion of the finished product being scrapped by the inspectors. The manufacturer assumed that if he were expected to produce universal joints of better quality, still more parts would be scrapped by the inspectors, and his costs would mount still higher. But the experienced automobile builder showed him that by applying a few simple principles of interchangeable manufacture, he could make all his parts alike from the start, within certain predetermined limits; and would not only cut down his waste to a minimum, but could also reduce his inspection force, and would have practically no joints returned by dissatisfied customers.

Some years later, the manufacturer of universal joints told his advisor that by applying the principles laid down for him in their talk he had been able not only to improve his product to a point where he never received complaints, but also to produce so cheaply that he now really was making money; whereas, when he turned out a lower grade product, he had barely been able to pay expenses and stay in business.

The Swedish Machine Tool Industry

By S. E. OSMAR

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THE machine tool industry in Sweden is very dull at present, and there is no immediate prospect for improvement. Very few machine tools are being manufactured, either for export or for the home market. Most of the plants are operating with reduced forces and short hours, doing just enough work to keep open. Practically everything that is being manufactured now in the various machine industries in Sweden is being made for stock, with the exception of a few standard lines, such as ball bearings. One of the reasons for this inactivity is the financial difficulties with which the machine tool as well as the other manufacturers of the country are confronted. Credit is not easily obtained, and the banks refuse loans under almost any conditions.

Obviously, there is very little market for American machine tools in Sweden at the present time, as even the Swedish and German makes of machines, which can be obtained at lower prices, have no sale. The orders that have been placed have been spasmodic. It may be said that until the constantly rising labor costs force the adoption of American methods of efficiency in manufacturing, there will be no market for high-production machinery in Sweden.

The Russian Soviet Government has recently placed an order for locomotives in Sweden, which has somewhat stimulated business, but conditions in Russia are so unstable that the value of these Russian contracts is doubtful, and cannot be considered as a permanent factor in improving business.

A notable post-war influence is perceptible in the quality of the Swedish machine tools now on the market. The grade of machinery known as "war machinery," which was produced rapidly to meet the acute demand during the war period and was of inferior quality, has disappeared. These poor-quality machines may be said to have disappeared in direct proportion to the decrease in demand. Better materials are now being used in the construction of machines. The small firms that sprang into existence during the war have almost all gone out of business, and the regular machine tool manufacturers are turning out machines of a quality comparable with those made in pre-war days.

Tendency toward Specialization in Manufacture

In general, industry in Sweden is waking up to a realization of the economies that can be effected by specialization, and there is a tendency for manufacturers to devote their energies and manufacturing facilities exclusively to the production of one line. It is possible in this way to reduce the cost of production materially. The fact, however, that the Swedish home market is so small that all industries of importance have to depend on exports has caused much discussion as to the advisability of this specialization. To depend almost wholly on export trade is precarious, considering the changes that have taken place in tariffs on imports in all countries; cases are known where tariffs have increased to such an extent as to make importation impossible.

Prices of Machine Tools

It is a fact of considerable interest that the prices of high-grade machine tools in Sweden are practically the same today as they were in January, 1919. Swedish manufacturers of such machines are neither willing nor able to reduce prices in order to sell their machines. As previously mentioned, pre-war quality is being maintained and in order to do this, it is necessary also to maintain prices at the present level. A general idea of the prices of machine tools in Sweden will be obtained from the following figures, which are based on present exchange (1 krona = 20 cents):

High-grade 28-inch lathe	$3280
High-grade 20-inch lathe	$2000 to $2200
High-grade 16-inch lathe	$1400
Cheaper grade 16-inch lathe	$ 720
German high-grade 2½-inch turret lathe	$2400
(This price was quoted when the exchange for the German mark was about 2.4 cents to 1 mark.)	
Swedish 2-inch turret lathe (cheaper grade)	$1340
Swedish 1¼-inch turret lathe (same make as 2-inch lathe)	$ 645
Plain manufacturing milling machine, size of table, 12 by 6 inches	$2470
High-grade vertical milling machine, size of table, 42 by 11 inches	$1400

German Competition

There is very little German competition in the machine tool line. This is due to the uncertain deliveries of German machine tools, and to the failure of German manufacturers to live up to the terms of their contracts as regards price. In most cases where contracts have been signed with German manufacturers, stating specifically that machines were to be made at a fixed price, the German makers have informed the buyers, when the machines were ready to be shipped, that the price had risen in the meantime, and that they were unable to supply the machines at the price quoted. In many instances, when the buyer agreed to pay the increase he was told that the machine had been disposed of, and he would have to wait for another machine to be made at a still higher price. The writer knows of cases where prices have been advanced again and again. This practice has injured the reputation of German manufacturers throughout the whole of Scandinavia. Several Scandinavian chambers of commerce have blacklisted German firms employing such practices, and it is surprising to see how many German manufacturers of high reputation previous to the war are on this list.

Labor Conditions

There are no serious labor troubles in Sweden at present. Wages are high, judged by pre-war standards, but the increase is offset by the cost of living, which rather than decreasing, has been steadily advancing in the last eighteen months. The average toolmaker is paid up to 50 cents an hour (at the present exchange rates) and machinists (both skilled and unskilled) receive 40 cents an hour.

No serious strikes have occurred since the enactment of the eight-hour law early this year. However, this law has had an injurious effect in some respects. According to its provisions an employer cannot ask an employe to work nor can an employe work voluntarily more than eight hours a day. If it is desired to operate a plant more than eight hours, special permission must be obtained from a governmental bureau, and over-time rates must be paid. This results in checking production and increasing the cost of manufacture, as well as in limiting the amount a workman can earn. Naturally, it is looked upon with disfavor both by the employers and by the employes. There is strong agitation for a repeal of the law, and it is likely that if it has not already been changed, it soon will be. Whatever steps are taken that will result in increased production will benefit not only the machine tool industry but business as a whole.

TESTING HIGH-SPEED STEEL STOCK

It is important that every bar of high-speed steel used in the manufacture of high-grade tools be subjected to a rigid test. The most careful machine work and hardening will not save a tool from the scrap heap if the steel is defective. Obviously, it is impossible to manufacture tools of a uniform quality from high-speed steel if the steel itself is not uniform. By uniform high-speed steel is meant a steel that is free from pipes, seams, cracks, segregated carbides, decarburization and fiber—a steel that will harden quickly and uniformly with a smooth velvety grain that is almost amorphous. That a steel should harden is not sufficient; the grain must be smooth and even, and the steel must be tough as well as hard. An even grain will not compensate for a pipe down the center; hardness combined with a woody structure means brittleness; and the value of the finest grain is absolutely nullified if the characteristic shiny crystalline ring of decarburization is present.

After exhaustive tests and experiments, the Fastfeed Drill & Tool Corporation, Toledo, Ohio, came to the conclusion that the only way to test high-speed steel properly was to harden it, and this method is used in testing every bar of high-speed steel that enters the Fastfeed plant. The procedure, as stated by Mr. Traphagen, metallurgist of the company, in a paper on "The Selection of High-speed Steel for Tools," read before the American Steel Treaters' Society convention in Philadelphia, is as follows: As soon as steel enters the receiving room it is placed on a special rack, and it does not leave the rack until it is either accepted or shipped back to the mill. A piece from each bar is hardened by preheating slowly and thoroughly at 1650 degrees F., and then heating quickly in a furnace maintained at 2400 degrees F., after which the piece is quenched in oil until cool. The hardened piece is then broken transversely and longitudinally, and the fractures are examined carefully with a small low-power lens.

If the piece breaks easily, suspicion is aroused, and either fiber or excessive carbides are looked for, as one or the other of these defects is generally found in brittle steel. If the steel is decarburized, the shiny crystalline ring will be seen at a glance; this is a condition which is frequently encountered. A pipe may not be detected in the transverse fracture, but the longitudinal break quickly reveals it. If the tungsten content is low, it is generally found that the structure is coarse and crystalline when hardened at the high heat of 2400 degrees F. Woody fibrous structures are very common, and always show up in the longitudinal fracture; in the transverse fracture they are often masked.

A bar is never rejected on a single test. If the sample from one end of a bar is defective, a piece is cut from the other end, and if that also fails a piece is cut from the middle of the bar and tested. In order to eliminate the possibility of incorrect heat-treatment, at least two, and often three men harden the samples on different days, without knowing where the samples come from. It is possible for an error to creep in in one hardening, but the average results obtained by different men on different days, where the defect appears again and again, is positive proof that the steel is faulty. The test must be fair, and no amount of retesting is spared if there is the slightest doubt that the results are not correct.

In order to determine if a clean, smooth, uniform structure is conclusive proof of the value of a steel, dozens of drills were made up from steel possessing these properties and subjected to tests in a heavy-duty drilling machine. They were jammed through foot after foot of heat-treated forgings, using very little lubricant. After standing up under this test they were taken out and bounced on a concrete floor time and again, to test for toughness, after which they were again placed in the drilling machine and the whole test repeated. These tests, together with many official competitive tests, have proved the value of fracture tests in selecting high-speed steel for drills and other tools.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' ANNUAL MEETING

Satisfactory progress is reported in the plans for the 1920 annual meeting of the American Society of Mechanical Engineers to be held in the Engineering Societies Building, 29 W. 39th St., New York City, December 7 to 10. In its selection of "Transportation" for the subject of the keynote session, the Committee on Meetings and Program feels that it has chosen the most important problem in post-war reconstruction. It is planned to subdivide the subject into a consideration of railroads, waterways, motor trucks, and terminals. Under railroads a subdivision will be made of short-line feeders and interurban trolley transportation. Men who will be able to enunciate the principles governing the solution of each of the problems in these subdivisions have been selected by the committee. The morning of December 9 will be devoted to the subdivisions, and in the afternoon the problem of transportation will be analyzed by a noted expert. This analysis will be followed by an open discussion on all phases of the subject. This entire session will treat with the problems of transportation from the economic as well as the engineering point of view, and it is confidently expected that the points brought out at the meeting will be of great value in educating the engineering profession and the public as to the exact requirements for a solution of this pressing problem.

A number of valuable papers sufficient to make up two general sessions have been received by the committee. Some of the subjects are: "Design of Large Center-crank Shafts," "Calibration of Nozzles," and "Strength of Gears." The subject of "Appraisal and Valuation" will also receive consideration at this meeting. A committee appointed by the president of the society will go over all of the papers previously presented before the society on this subject and prepare a résumé for presentation at the session. Additional papers will be procured where necessary in order to round out the subject. The sub-committee in charge of the Woodworking Session has prepared a tentative program which will prove of great value to all those interested in the adaptation of engineering principles to woodworking.

Initial sessions will be held by six of the newly formed professional sections. The Management Section is to devote its meeting to a consideration of the life and work of Henry L. Gantt. The Professional Section on Fuels will present four papers, the subjects and authors of which are as follows: "Fuel Supply of World," L. P. Breckenridge; "Low-temperature Distillation of Coal," O. P. Hood; "Fuel Conservation versus Money Conservation," D. M. Myers; and "Form Value of Energy in Relation to its Production, Transportation, and Application," Chester G. Gilbert and Joseph E. Pogue. The subjects of the three papers to be presented at the Railroad Section's session are as follows: "Static Adjustment of Trucks on Curves," "Increasing the Capacity of Old Locomotives," and "Modernizing Locomotive Terminals."

The Professional Section on Power is planning a symposium on Centralization of Power. It is proposed to discuss the mechanical phases of the centralized power circuit and the super-power plants to be built in connection with it. The Section on Textiles has presented its program, which covers the following subjects: "Humidity Control in Textile Plants," "Power Application to Finishing Plants," "Textile Fabrication for Mechanical Purposes," "Ventilation of Dye Houses." The Machine Shop Section will present papers on shop problems, among which is announced a paper by Earle Buckingham on "Side Cutting of Thread Milling Hobs."

Other subjects included in the tentative program are: "Foundations for Machinery," W. W. Akimoff; "Tests of Rear Axle Worm Drive," K. Heindlhofer; and "Constitution and Properties of Boiler Tubes," A. E. White.

An important and valuable feature of this next annual meeting will be the memorial session to be held for Past-President Dr. John A. Brashear.

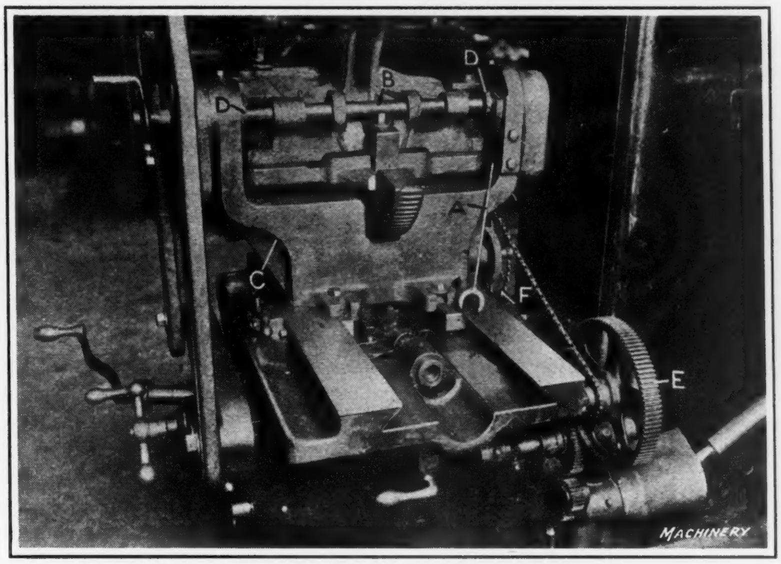

Fig. 1. Milling Machine equipped with Hinged Fixture for Use in performing Gang Milling Operations on Circular Segments

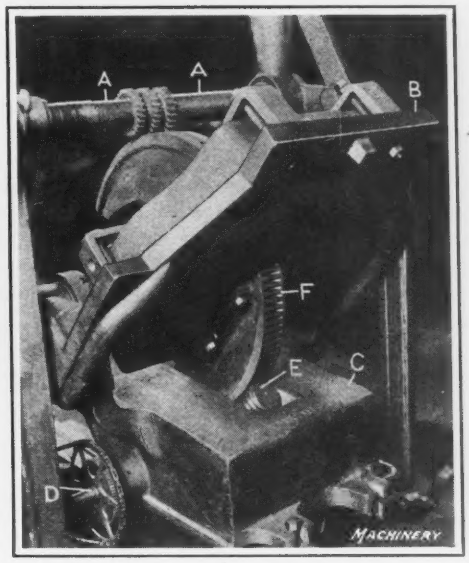

Fig. 2. View of Milling Fixture with Table Elevated, showing Special Feed Gearing

Milling Fixture for Circular Segments

Features of Construction of a Hinged Milling Fixture Designed for Use in Performing Gang Milling Operations on Circular Segments

IN gang-milling the circular segments of horn slides used on bevel gear cutting machines, Gould & Eberhardt, Newark, N. J., employ a hinged type of milling fixture which has a number of interesting features. The horn slide on which this milling operation is performed is shown in Fig. 3, and the surfaces thus finished are the two circular segment slots and the sections between these slots, as indicated by finish marks on the curved section of the casting. It will be seen from Fig. 2 that the gang of cutters employed for this milling operation consists of three straddle-milling cutters for finishing the bottoms and taking the side cuts, and two plain milling cutters for milling the outside surfaces of the circular segment, that is, the surfaces of the sections between the slots having a radius of 11⅛ inches. (See Fig. 3).

The operation is performed on a No. 4 Cincinnati milling machine, the fixture being bolted to the table as shown in Fig. 1. This illustration is a view of the front of the machine, showing the method of transmitting power for feeding the work past the cutters from the regular feed-gears of the milling machine. Fig. 2 is a view taken from the rear of the machine, and shows the fixture near its extreme tilted position, as well as the gang of milling cutters and the sleeves *A*, which serve the double purpose of locating the cutters laterally relative to the work, and of gaging the vertical distance between the arbor and the table of the machine. This distance is determined by means of gage *A*, Fig. 1, the U-shaped end of which fits over the aligning shaft *B*, so that when the gage is swung to a vertical position it will just pass under the sleeve. For the completion of this milling operation, a roughing and two finishing cuts are required, so that after the roughing cut has been taken, the table must be elevated sufficiently to permit the cutters to finish the surfaces. The amount of elevation thus required is determined by the use of sleeves of smaller diameter.

The machines upon which these slides are used are made in a number of sizes, so that in designing a fixture to accommodate the various horn slides required for these machines, provision was made for employing one base *C*, to which a hinged table *B*, Fig. 2, of the proper size for handling the particular casting to be milled may be attached. The method of hinging the table to the base of the fixture

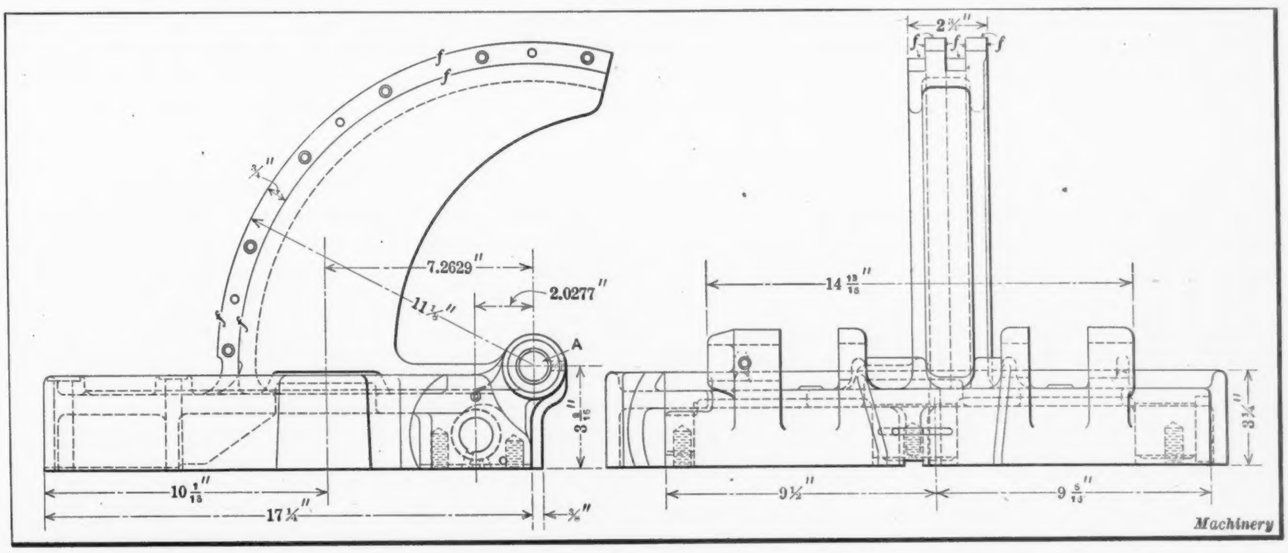

Fig. 3. Horn Slide for Vertical Gear-cutting Machine, in which a Gang Milling Operation is performed as shown in Figs. 1 and 2

may be seen quite clearly in Fig. 1, in which are shown the two bushings *D* that are fastened in the bearings of the base and that support the swinging table by means of similar bearings in that member.

In mounting the work on the table of the fixture, it is seated on its previously finished base and located by the aligning shaft *B*, Fig. 1, which fits the finished holes in the bearing bushings and the holes *A*, Fig. 3 in the work. With the work thus located on the table, it is secured to it by the use of regular clamping straps. The special equipment necessary to transmit the table feed movement to the fixture consists of a gear *E*, Fig. 1, which has a sprocket wheel on its hub by means of which sprocket wheel *F* on the bevel gear shaft of the fixture is driven by a sprocket chain. A better idea of the method of transmitting the feed to the fixture may be had by referring to the rear view, Fig. 2, where the sprocket wheel is clearly shown, as well as the bevel gear shaft *D*, which extends through the base of the fixture and carries a bevel gear meshing with a similar gear cast integral with the worm *E*. Segment gear *F* is attached to the swinging table of the fixture, so that as power is transmitted from the feed-shaft of the milling machine, the table may be swung radially from its pivotal support and thus pass the work under the cutters.

It has previously been mentioned that three cuts—a roughing and two finishing cuts—are required to finish the surfaces. The reason for taking the second finishing cut is that considerable spring is produced in the arbor during the first finishing cut (and also in the roughing cut) due to the length of the arbor and the nature of the work. It is almost impossible to provide an additional support for the cutters between the milling machine spindle and the outboard support of the arbor, since on its extreme upward movement the swinging table of the fixture and the work which it carries would interfere with any such means of providing a more rigid support for the arbor. The second finishing cut, therefore, is taken merely to correct the inaccuracies produced by the springing of the arbor during the first finishing cut.

The rate of feed for the roughing and first finishing cuts is 0.006 inch per revolution of the cutters, and for the second finishing cut 0.016 inch per cutter revolution. The cutters revolve at a rate of 36 revolutions per minute during the first two cuts and at 54 revolutions per minute during the final finishing cut. The total time required to perform this milling operation is 3½ hours per piece which is divided as follows: 1½ hours for the roughing cut; 1¾ hours for the two finishing cuts; and 15 minutes for loading and unloading the fixture.

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NEXT FOREIGN TRADE CONVENTION TO BE HELD IN CLEVELAND

At the seventh annual meeting of the National Foreign Trade Council held in New York City, it was decided to hold the eighth annual foreign trade convention in the spring of 1921 in Cleveland, Ohio. Previous national foreign trade conventions have been held in Washington, D. C., St. Louis, New Orleans, Pittsburg, Cincinnati, Chicago, and San Francisco. In deciding upon Cleveland as the place for the next convention, the council took into consideration the fact that the most productive industrial district of the United States lies within an area bounded by Buffalo, Pittsburg, Dayton, Cincinnati, Indianapolis, Chicago, and Detroit, and that Cleveland may well be considered as a central point within this area. Practically every conceivable article made for export is manufactured in large quantities within the area described. This area is the center of the iron and steel, automobile, truck, tractor, rubber, coal, and machine tool manufacturing industries in the United States. While New England and eastern Pennsylvania also occupy an important place as manufacturing centers, the total production of any one of the manufactures mentioned in this part of the country does not equal the production in the area described.

CASEHARDENING BY CYANOGEN GAS

The development of a process of casehardening parts by cyanogen gas is described in a paper recently presented before the Pittsburg branch of the Heat Treaters' Research Society by William J. Merten, metallurgical engineer of the Westinghouse Electric & Mfg. Co. The author first called attention to the fact that iron and low-carbon steels absorb carbon from carburizers very readily when in contact with these carbonaceous materials at temperatures above the upper critical point of the metal.

The quantity of carbon so absorbed depends upon: (1) The temperature of the steel; the higher the temperature, the faster and deeper the penetration of the carbon. (2) The character of the carburizer; this is a very important factor in successful casehardening. The elementary carbon is only of secondary importance. Oxygen and nitrogen compounds, which are added to or are present in the energizers that form carbonaceous compounds with solid carbon, are necessary to generate nascent carburizing mixtures of carbon monoxide and cyanogen gases. (3) The percentage of carbon present in the steel being casehardened. This also has a marked influence on the affinity of the material for more carbon up to saturation; that is, a low-carbon steel absorbs carbon faster than a high-carbon steel. (4) The presence of chromium, tungsten, or manganese. These elements accelerate the absorption of carbon, since they form double carbides with the iron. Nickel and silicon, however, retard absorption; the fact that they form solid solutions with iron may be the cause for this retardation.

From the statement made regarding the second of the foregoing factors, which emphasizes the necessity of nascent carbonaceous-gas formation for the penetration and absorption of carbon, it is readily conceivable that if a properly heated piece of steel is brought into contact with pure nascent gas, continuously generated in a separate unit or chamber, and preferably under pressure, the conditions for penetration would approach the ideal. A process of this kind is presented in the following, but, before describing it, a survey of the processes now in vogue, with their disadvantages and deficiencies, will be given.

Present-day Methods of Casehardening

The most common method of casehardening is to pack steel parts in a metal box filled with carburizing materials and submit the tightly closed box and contents to a sufficiently high temperature for an adequate length of time to obtain the desired depth of case. This process is simple, and assures fair success if properly conducted in accordance with a prescribed procedure, which has been found by experiments to give definite results under specific conditions.

The disadvantages of this process are manifold, some of the more important being: (1) The uncertainty of proper reaction within the closed box. (2) The difficulty in duplicating results as predetermined, because of the non-uniformity of carburizers. (3) The long exposure of the steel to a heat that is not well controlled, which results in a questionable structural condition. (4) The high cost of operation due to the inefficient heating method, the cost of boxes, and their rapid deterioration by oxidation or scaling.

A second method of casehardening is to immerse steel articles in a cyanide bath heated to about 1580 degrees F. This process is convenient and effective only on small articles and where the required depth is not more than from 0.005 to 0.015 inch, or where a mere surface hardening is wanted. This is a fast case-forming method, being accomplished in from ten to fifteen minutes. The outstanding disadvantage of this process is the impossibility of producing uniform cases. The parts that are deep in the melted bath do not receive the same depth of penetration as the parts near the surface because the evolution of the cyanide gases at or near the surface favors penetration. It is hardly feasible to have pots with a sufficient surface area to accommodate the casehardening of a plant.

A third method of casehardening consists of either dipping a cherry-red piece of steel or tool into a container of powdered cyanide salt, such as potassium cyanide, sodium cyanide, or ferro- and ferri-cyanides, or sprinkling the powdered salt on the red-hot steel surface, and putting the steel back in the fire. The casehardening produced in this way is superficial, and resistance to excessive wear cannot be expected.

In a fourth method, the carburizing gases are passed over a piece of steel heated in a retort. This process is applicable to parts that are intricate in design. All the processes referred to serve the needs of the different industries more or less satisfactorily. Box casehardening is dirty and wasteful and sometimes unsatisfactory. Casehardening by firing in fused cyanide salt is inefficient, unreliable, dangerous, and costly. Retort casehardening with carbonaceous gases is a step in the right direction, but it leaves something to be desired on account of the selection of the carbonaceous gases and the method of application.

Casehardening by Cyanogen Gas

The next process to be discussed, although still in the experimental stage, appears to present opportunities for efficiency, preservation of the product, simplicity of operation, assurance of uniformity and duplication of results, speed of operation, reasonable cost, and a wide range of utility. This process may be called "regenerated cyanogen-gas casehardening." It has long been recognized that cyanogen is the most efficient carburizing gas, that the case obtained is of a greater uniformity, is more rapidly produced, and is deeper, than one produced by carbon monoxide. However, the highly poisonous character of the substance has been a serious objection to its use, and resulted in the tendency to lead the gas wastefully to the stack, instead of controlling it to obtain maximum efficiency.

The principle upon which the new process is based is the casehardening of steel and iron-alloy articles in cyanogen gas evolved from a container filled with an alkali cyanide salt, heated by electrical energy or other means to accomplish the vaporization or boiling of the salt. The parts being treated are independently heated out of contact with the fused cyanide salt. The advantage of this will readily be appreciated on recalling the fact that casehardening is produced by contact with gaseous and not with solid carbon, and more especially with cyanogen gas. The depth of penetration is then only a function of the uniformity of the temperature of the article treated and the duration of treatment. Nascent cyanogen gas has a speed of penetration of four or five times that of carbon monoxide.

The furnace used in this process embodies the regenerative principle, since the excess gases not absorbed by the steel are forced under pressure into the fused cyanide bath and reheated. This causes a vigorous stirring of the bath, and the cyanogen gas is evolved with more energy and in larger quantities, and more vigorously attacks the steel surface, causing accelerated and deeper penetration. This regenerative type of furnace is a means of using the rather expensive salt economically, as the nitrogen gas on returning will combine with the sodium, and carbon in some cheap form such as charcoal can be added to the liquid as required, thereby retaining the original supply of cyanide salt intact. Therefore, this process may compete with the present box or packing carburizing processes. Sodium cyanide melts at 1112 degrees F. and boils at 1472 degrees F. Thus, the temperature of the pot must not be less than the latter, and to absorb this gas effectively, the steel must be at a temperature above the upper critical point, or about 1650 degrees F.

Advantages Obtained by Casehardening with Cyanogen Gas

Some of the advantages of this process are as follows: (1) The temperature control is more perfect, since a pyrometer is inserted directly into the heating chamber. (2) A finer, more uniform, and deeper case is secured than by any other process, and as less time is required, the cost is less. (3) The elimination of the use and storage of carburizers and carburizing boxes.

The advantage of cyanogen gas for casehardening has never been fully appreciated nor has the maximum efficiency been obtained during previous tests, as the temperature was at or below the boiling point of sodium cyanogen, which is considerably below the upper critical point of the steel. But, even in this unfavorable condition an exceptionally high speed of penetration has been noted. While some of the less important features of this process are still speculative in character, because of the experimental stage of the development, the method is based upon well-known principles, and the conclusions have been drawn from a careful study of general casehardening practice.

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ANNUAL CONGRESS OF NATIONAL SAFETY COUNCIL

The ninth annual congress of the National Safety Council was held September 27 to October 1, inclusive, at Milwaukee, Wis. This was the greatest convention of its kind in the history of the safety movement, not only in the numbers that attended, but in the diversity of interests that were represented, and in the actual work accomplished. More than 3100 persons were registered, the delegates being men from the various industries, educators of all types, municipal officials, chamber of commerce and other trade association representatives and newspaper and magazine correspondents.

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What is perhaps the largest welded tank ever built was recently completed by the Welded Products Co. at Birmingham, Ala., for the Liquid Carbonic Co. The tank is 22 feet in diameter and 30 feet high. It is made of 1/4-inch steel plates, joined at the seams by oxy-acetylene welding. The big tank has satisfactorily withstood the required tests, and has been found to be gas-tight in all of the welded seams. Oxy-acetylene welding has been used with remarkable success in tank construction, and has for some time been used for many large tanks for gasoline storage and other uses. The welded construction is claimed to have proved thoroughly satisfactory and to be very much cheaper than riveted tanks of the same capacity. The welded tank is also said to have a distinct advantage in the fact that it is not so susceptible to rust as the riveted tank.

may be seen quite clearly in Fig. 1, in which are shown the two bushings *D* that are fastened in the bearings of the base and that support the swinging table by means of similar bearings in that member.

In mounting the work on the table of the fixture, it is seated on its previously finished base and located by the aligning shaft *B*, Fig. 1, which fits the finished holes in the bearing bushings and the holes *A*, Fig. 3 in the work. With the work thus located on the table, it is secured to it by the use of regular clamping straps. The special equipment necessary to transmit the table feed movement to the fixture consists of a gear *E*, Fig. 1, which has a sprocket wheel on its hub by means of which sprocket wheel *F* on the bevel gear shaft of the fixture is driven by a sprocket chain. A better idea of the method of transmitting the feed to the fixture may be had by referring to the rear view, Fig. 2, where the sprocket wheel is clearly shown, as well as the bevel gear shaft *D*, which extends through the base of the fixture and carries a bevel gear meshing with a similar gear cast integral with the worm *E*. Segment gear *F* is attached to the swinging table of the fixture, so that as power is transmitted from the feed-shaft of the milling machine, the table may be swung radially from its pivotal support and thus pass the work under the cutters.

It has previously been mentioned that three cuts—a roughing and two finishing cuts—are required to finish the surfaces. The reason for taking the second finishing cut is that considerable spring is produced in the arbor during the first finishing cut (and also in the roughing cut) due to the length of the arbor and the nature of the work. It is almost impossible to provide an additional support for the cutters between the milling machine spindle and the outboard support of the arbor, since on its extreme upward movement the swinging table of the fixture and the work which it carries would interfere with any such means of providing a more rigid support for the arbor. The second finishing cut, therefore, is taken merely to correct the inaccuracies produced by the springing of the arbor during the first finishing cut.

The rate of feed for the roughing and first finishing cuts is 0.006 inch per revolution of the cutters, and for the second finishing cut 0.016 inch per cutter revolution. The cutters revolve at a rate of 36 revolutions per minute during the first two cuts and at 54 revolutions per minute during the final finishing cut. The total time required to perform this milling operation is 3½ hours per piece which is divided as follows: 1½ hours for the roughing cut; 1¾ hours for the two finishing cuts; and 15 minutes for loading and unloading the fixture.

* * *

NEXT FOREIGN TRADE CONVENTION TO BE HELD IN CLEVELAND

At the seventh annual meeting of the National Foreign Trade Council held in New York City, it was decided to hold the eighth annual foreign trade convention in the spring of 1921 in Cleveland, Ohio. Previous national foreign trade conventions have been held in Washington, D. C., St. Louis, New Orleans, Pittsburg, Cincinnati, Chicago, and San Francisco. In deciding upon Cleveland as the place for the next convention, the council took into consideration the fact that the most productive industrial district of the United States lies within an area bounded by Buffalo, Pittsburg, Dayton, Cincinnati, Indianapolis, Chicago, and Detroit, and that Cleveland may well be considered as a central point within this area. Practically every conceivable article made for export is manufactured in large quantities within the area described. This area is the center of the iron and steel, automobile, truck, tractor, rubber, coal, and machine tool manufacturing industries in the United States. While New England and eastern Pennsylvania also occupy an important place as manufacturing centers, the total production of any one of the manufactures mentioned in this part of the country does not equal the production in the area described.

CASEHARDENING BY CYANOGEN GAS

The development of a process of casehardening parts by cyanogen gas is described in a paper recently presented before the Pittsburg branch of the Heat Treaters' Research Society by William J. Merten, metallurgical engineer of the Westinghouse Electric & Mfg. Co. The author first called attention to the fact that iron and low-carbon steels absorb carbon from carburizers very readily when in contact with these carbonaceous materials at temperatures above the upper critical point of the metal.

The quantity of carbon so absorbed depends upon: (1) The temperature of the steel; the higher the temperature, the faster and deeper the penetration of the carbon. (2) The character of the carburizer; this is a very important factor in successful casehardening. The elementary carbon is only of secondary importance. Oxygen and nitrogen compounds, which are added to or are present in the energizers that form carbonaceous compounds with solid carbon, are necessary to generate nascent carburizing mixtures of carbon monoxide and cyanogen gases. (3) The percentage of carbon present in the steel being casehardened. This also has a marked influence on the affinity of the material for more carbon up to saturation; that is, a low-carbon steel absorbs carbon faster than a high-carbon steel. (4) The presence of chromium, tungsten, or manganese. These elements accelerate the absorption of carbon, since they form double carbides with the iron. Nickel and silicon, however, retard absorption; the fact that they form solid solutions with iron may be the cause for this retardation.

From the statement made regarding the second of the foregoing factors, which emphasizes the necessity of nascent carbonaceous-gas formation for the penetration and absorption of carbon, it is readily conceivable that if a properly heated piece of steel is brought into contact with pure nascent gas, continuously generated in a separate unit or chamber, and preferably under pressure, the conditions for penetration would approach the ideal. A process of this kind is presented in the following, but, before describing it, a survey of the processes now in vogue, with their disadvantages and deficiencies, will be given.

Present-day Methods of Casehardening

The most common method of casehardening is to pack steel parts in a metal box filled with carburizing materials and submit the tightly closed box and contents to a sufficiently high temperature for an adequate length of time to obtain the desired depth of case. This process is simple, and assures fair success if properly conducted in accordance with a prescribed procedure, which has been found by experiments to give definite results under specific conditions.

The disadvantages of this process are manifold, some of the more important being: (1) The uncertainty of proper reaction within the closed box. (2) The difficulty in duplicating results as predetermined, because of the non-uniformity of carburizers. (3) The long exposure of the steel to a heat that is not well controlled, which results in a questionable structural condition. (4) The high cost of operation due to the inefficient heating method, the cost of boxes, and their rapid deterioration by oxidation or scaling.

A second method of casehardening is to immerse steel articles in a cyanide bath heated to about 1580 degrees F. This process is convenient and effective only on small articles and where the required depth is not more than from 0.005 to 0.015 inch, or where a mere surface hardening is wanted. This is a fast case-forming method, being accomplished in from ten to fifteen minutes. The outstanding disadvantage of this process is the impossibility of producing uniform cases. The parts that are deep in the melted bath do not receive the same depth of penetration as the parts near the surface because the evolution of the cyanide gases at or near the surface favors penetration. It is hardly feasible to have pots with a sufficient surface area to accommodate the casehardening of a plant.

A third method of casehardening consists of either dipping a cherry-red piece of steel or tool into a container of powdered cyanide salt, such as potassium cyanide, sodium cyanide, or ferro- and ferri-cyanides, or sprinkling the powdered salt on the red-hot steel surface, and putting the steel back in the fire. The casehardening produced in this way is superficial, and resistance to excessive wear cannot be expected.

In a fourth method, the carburizing gases are passed over a piece of steel heated in a retort. This process is applicable to parts that are intricate in design. All the processes referred to serve the needs of the different industries more or less satisfactorily. Box casehardening is dirty and wasteful and sometimes unsatisfactory. Casehardening by firing in fused cyanide salt is inefficient, unreliable, dangerous, and costly. Retort casehardening with carbonaceous gases is a step in the right direction, but it leaves something to be desired on account of the selection of the carbonaceous gases and the method of application.

Casehardening by Cyanogen Gas

The next process to be discussed, although still in the experimental stage, appears to present opportunities for efficiency, preservation of the product, simplicity of operation, assurance of uniformity and duplication of results, speed of operation, reasonable cost, and a wide range of utility. This process may be called "regenerated cyanogen-gas casehardening." It has long been recognized that cyanogen is the most efficient carburizing gas, that the case obtained is of a greater uniformity, is more rapidly produced, and is deeper, than one produced by carbon monoxide. However, the highly poisonous character of the substance has been a serious objection to its use, and resulted in the tendency to lead the gas wastefully to the stack, instead of controlling it to obtain maximum efficiency.

The principle upon which the new process is based is the casehardening of steel and iron-alloy articles in cyanogen gas evolved from a container filled with an alkali cyanide salt, heated by electrical energy or other means to accomplish the vaporization or boiling of the salt. The parts being treated are independently heated out of contact with the fused cyanide salt. The advantage of this will readily be appreciated on recalling the fact that casehardening is produced by contact with gaseous and not with solid carbon, and more especially with cyanogen gas. The depth of penetration is then only a function of the uniformity of the temperature of the article treated and the duration of treatment. Nascent cyanogen gas has a speed of penetration of four or five times that of carbon monoxide.

The furnace used in this process embodies the regenerative principle, since the excess gases not absorbed by the steel are forced under pressure into the fused cyanide bath and reheated. This causes a vigorous stirring of the bath, and the cyanogen gas is evolved with more energy and in larger quantities, and more vigorously attacks the steel surface, causing accelerated and deeper penetration. This regenerative type of furnace is a means of using the rather expensive salt economically, as the nitrogen gas on returning will combine with the sodium, and carbon in some cheap form such as charcoal can be added to the liquid as required, thereby retaining the original supply of cyanide salt intact. Therefore, this process may compete with the present box or packing carburizing processes. Sodium cyanide melts at 1112 degrees F. and boils at 1472 degrees F. Thus, the temperature of the pot must not be less than the latter, and to absorb this gas effectively, the steel must be at a temperature above the upper critical point, or about 1650 degrees F.

Advantages Obtained by Casehardening with Cyanogen Gas

Some of the advantages of this process are as follows: (1) The temperature control is more perfect, since a pyrometer is inserted directly into the heating chamber. (2) A finer, more uniform, and deeper case is secured than by any other process, and as less time is required, the cost is less. (3) The elimination of the use and storage of carburizers and carburizing boxes.

The advantage of cyanogen gas for casehardening has never been fully appreciated nor has the maximum efficiency been obtained during previous tests, as the temperature was at or below the boiling point of sodium cyanogen, which is considerably below the upper critical point of the steel. But, even in this unfavorable condition an exceptionally high speed of penetration has been noted. While some of the less important features of this process are still speculative in character, because of the experimental stage of the development, the method is based upon well-known principles, and the conclusions have been drawn from a careful study of general casehardening practice.

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The German Machine Tool Industry

From MACHINERY'S Special Correspondent

Berlin, October 7

BUSINESS conditions in the machine tool industry are very unsatisfactory. Dealers do not buy, as they have large stocks on hand. The manufacturers of machine tools run their plants only from four to six hours a day, and in some cases they have shut down entirely. There are difficulties in every direction—lack of coal, lack of raw materials, a great decrease in the export trade, which threatens to come to a standstill, special export taxes, and labor troubles.

The Special Export Tax

The special export tax is very serious, and the president of the Association of German Machine Manufacturers, which is a general association including all the specialized associations of builders of different kinds of machinery, such as the Association of Machine Tool Builders, recently stated that this tax alone might mean the ruin of the whole German machine tool industry. This special export tax, which has been fixed at 6 per cent on the total invoice of machine tools, is being raised for the purpose of providing miners and other workmen employed in fatiguing occupations with extra rations of food, and the proceeds from the tax will be spent on social welfare. It is, therefore, also known as a "social" tax. It has been reduced on some classes of goods for export, but there is no prospect of its being reduced or eliminated in the case of machine tools.

German Manufacturers no Longer Able to Compete on Price in World's Markets

While there are no specific figures available showing how the prices of machine tools abroad compare with those at which German manufacturers could sell in a competing market, the conditions in some other machine building and tool making industries will indicate the situation. In one case, woodworking machinery is being sold by a Swedish firm in Sweden at a price corresponding to 11,890 marks, while a similar machine offered by a German manufacturer is sold in the domestic German market for 13,325 marks, and to this price 20 per cent would have to be added for freight and duty were the machine to be sold in competition in Sweden. In another case a machine is built in Sweden at a price corresponding to 16,400 marks, where the domestic German price is 21,000 marks, to which 20 per cent would have to be added for freight and import duty.

Comparing with prices in the United States, band saws are being sold in the domestic American market at prices corresponding to approximately 9120 marks, where the German domestic price is 13,950 marks. One type of wood planer is sold for 14,000 marks in the United States, and 16,500 marks in the German domestic market; molding machines for wood—11,400 marks in the United States, as against 13,900 marks in Germany. It is evident that on this basis it is not possible for the German machine builders to compete in the world's markets.

In tools the conditions are similar. The foreign business has ceased to a considerable extent, if not altogether. Files, for example, are offered in other industrial countries at one-third less than the German prices. Out of 174 firms with 12,500 workmen in one tool and hardware district of Germany 100 firms with 8000 men work exclusively on stock, and there is no improvement in the situation at present.

International Fair in Frankfort on the Main

The machine tool exhibition at the Frankfort Fair was of smaller dimensions than that at the Leipzig Fair last spring, but there was much to be seen in regard to new developments. The German machine tool manufacturers at the present time are making a distinct effort to reduce the time in machining work by increasing cutting speeds and feeds as well as by speeding up the operations. Among the more interesting machines exhibited were automatic sharpening machines for metal slitting saws by Fontaine & Co., Frankfort, and electric welding machines by the Mollwerke of Chemnitz. The Griesheim-Elektron firm also exhibited welding and cutting machines of novel design. Among these was a series of small, extremely handy machines, as well as a type known as a "longitudinal" cutting machine so arranged that by operating a small handwheel, plate after plate could be cut off in desired widths or thicknesses in a remarkably short time. The same firm also exhibited machines for cutting out circular and special shapes. Measuring tools were exhibited indicating the great progress that has been made in the optical type of measuring instruments and testing devices.

New Business Enterprises

There has been a considerable amount of foreign capital invested in Germany recently. The Berndorfer Metallwarenfabrik Arthur Krupp, Ltd., has been sold to a French group of financiers. Siemens & Halske, Ltd., have redoubled their capital, and it is reported that a very large part of the new stock has been taken over by American capitalists. The amount placed in America will be used for buying raw materials, particularly copper, there.

The Schneider interests of Paris have obtained control of a great many industrial works in Austria, among others the Skodawerke of Pilsen, and the Rustonwerke of Prague. These firms will be combined into a firm known as Union Europeenne Industrielle et Financiers with headquarters in Paris.

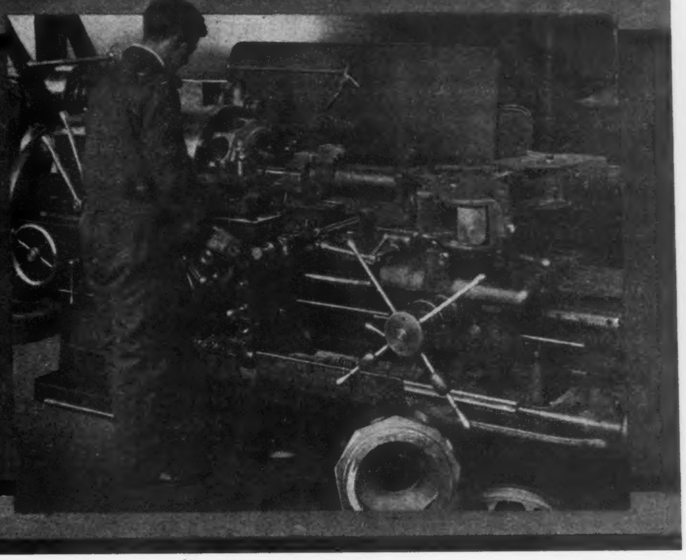
A large company has been formed under the name of the American Steel Engineering & Automotive Products, Ltd., (abbreviated "Amstea"). This company, it is stated, intends to import American steel into Germany and also to promote German exports.

Decreased Efficiency of Workmen

The following figures on the decreased efficiency of workmen and on the increase of manufacturing costs in a German machine tool plant may be of interest. In the foundry, in 1914, the average annual output of castings per molder was approximately 42 metric tons; in 1919 it was 22 tons. Meanwhile, the average wages in the foundry increased from 34 marks per week to 248 marks per week. In the machine shop, in 1913, the average amount of material machined per man per year was about 7270 kilograms; in 1919 it was only 2218 kilograms. The rise of wages for machinists was four-fold. In July, 1914, a skilled man earned 0.80 mark per hour; at the beginning of 1920 he received 3.30 marks per hour; but the purchasing power of the wages in consequence of the depression of the money dropped so that a wage of 3.30 marks per hour in 1920 scarcely corresponded to an hourly rate of 0.33 mark per hour in 1914.

In the shops of the Allgemeine Elektrizitätsgesellschaft, wages of unskilled labor rose in a greater degree than those of skilled labor. In 1914 skilled men received 0.76 mark per hour, and at the beginning of 1920, 4.25. Unskilled labor in 1914 earned 0.40, and in March, 1920, 4.10 marks. The minimum weekly living expenses for a workman's family of four members amounted in February, 1920 (average in 200 German cities) to 295 marks.

Machining Airplane Engine Parts



Tooling Equipments and a Special Indexing Work-holding Fixture Used in Connection with the Turret Lathe Practice of Alfred Herbert, Ltd., Coventry, England

THE articles on turret lathe practice that have been published in recent numbers of MACHINERY dealt with the practice of the manufacturers of machines of this type which are built in this country. The present article contains a description of the tooling equipments provided for machining several airplane engine parts on turret lathes manufactured by Alfred Herbert, Ltd., Coventry, England. The method of mounting the work in the machine for the different operations, and the various steps in each operation will be described in detail.

Tooling Equipments Required in First and Second Operations on the Nose-piece of an Airplane Engine

The airplane engine nose-piece illustrated in Fig. 1 is a steel drop-forging which is machined all over in four operations performed on turret lathes. The machining of this piece requires the use of a large number of tools and is an excellent example of modern turret lathe practice. In deciding upon the methods to be employed in the production of such a part, it should be remembered that drop-forgings usually have a hard skin which rapidly destroys the cutting edge of tools. For this reason it is advisable, when possible, to drill the various holes in the part instead of having them formed in the forging operation. The increased life of the tools more than compensates for the additional metal. For the same reason it is often more economical to produce a part of this type from a blank cylindrical piece of steel instead of from a forging, even though the time consumed in machining the part is somewhat longer. Forming tools should never be used in cutting through the scale, and a primary roughing cut should be taken on surfaces which are to be machined by a tool of this type.

A lay-out of the tooling equipment used in the first operation on the part is shown in Fig. 2. The dot-and-dash lines indicate the outline of the exterior surfaces of the part as it comes from the drop-hammer. The various steps in this operation are taken in the following sequence: (1) The work is mounted on the machine, being held in a 15-inch Coventry chuck provided with hardened jaws that grip it along surface *A*. It is located in the chuck by means of surface *B* coming in contact with the heads of three set-screws in the jaws, which are provided for this purpose. (2) A spot is drilled in end *C* by the flat starting drill which is held in a split bushing mounted in the holder in Face 1 of the turret. (3) Hole *D* is rough-drilled by the drill mounted in the holder in Face 3 of the turret. This drill is 1⅞ inches in diameter so that the hole is drilled about 3.3 millimeters less in diameter than the minimum dimension given for hole *D* in Fig. 1. (4) The hardened bushing mounted on the end of the holder in Face 5 of the turret is inserted in hole *D* to provide a support for the small end of the work during the remaining steps performed on this machine. (5) Surface *C* is rough-faced and surface *E* rough-turned by tool *a* which is mounted in the square turret. (6) Surface *G* is rough-turned from surface *C* to surface *I*, and surface *I* is rough-faced by tool *b* which is mounted in the square turret. (7) Taper surface *H* is rough-formed by the forming tool *c* which is mounted in a tool-holder on the rear of the cross-slide. (8) Surface *E* is turned to a diameter of 8.010 inches in order to adapt it for mounting in the chucking fixtures used in succeeding operations; surface *I* is faced; and surface *F* is turned; all of these cuts being taken by tool *d* which is mounted in the square turret. (9) The work is removed from the machine.

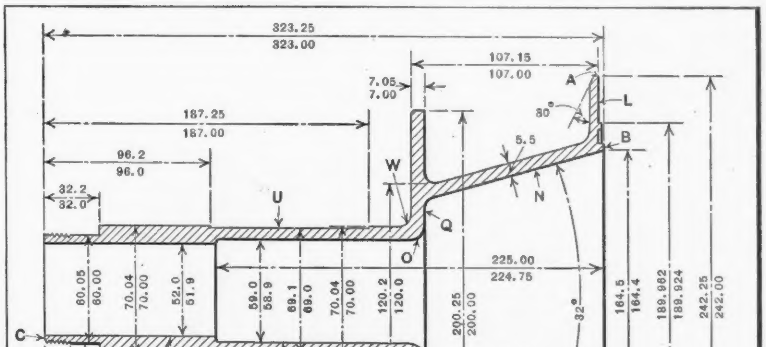


Fig. 1. Dimensioned Drawing of Airplane Engine Nose-piece

The tooling equipment used in the second operation on the forging is illustrated in Fig. 3. A special face-plate fixture is provided for mounting the work on the machine. This fixture contains a recess into which surface *E* of the work is seated, the work being held in the chuck by means of three clamps which bear against surface *J*. The order of the various steps in this operation is as follows: (1)

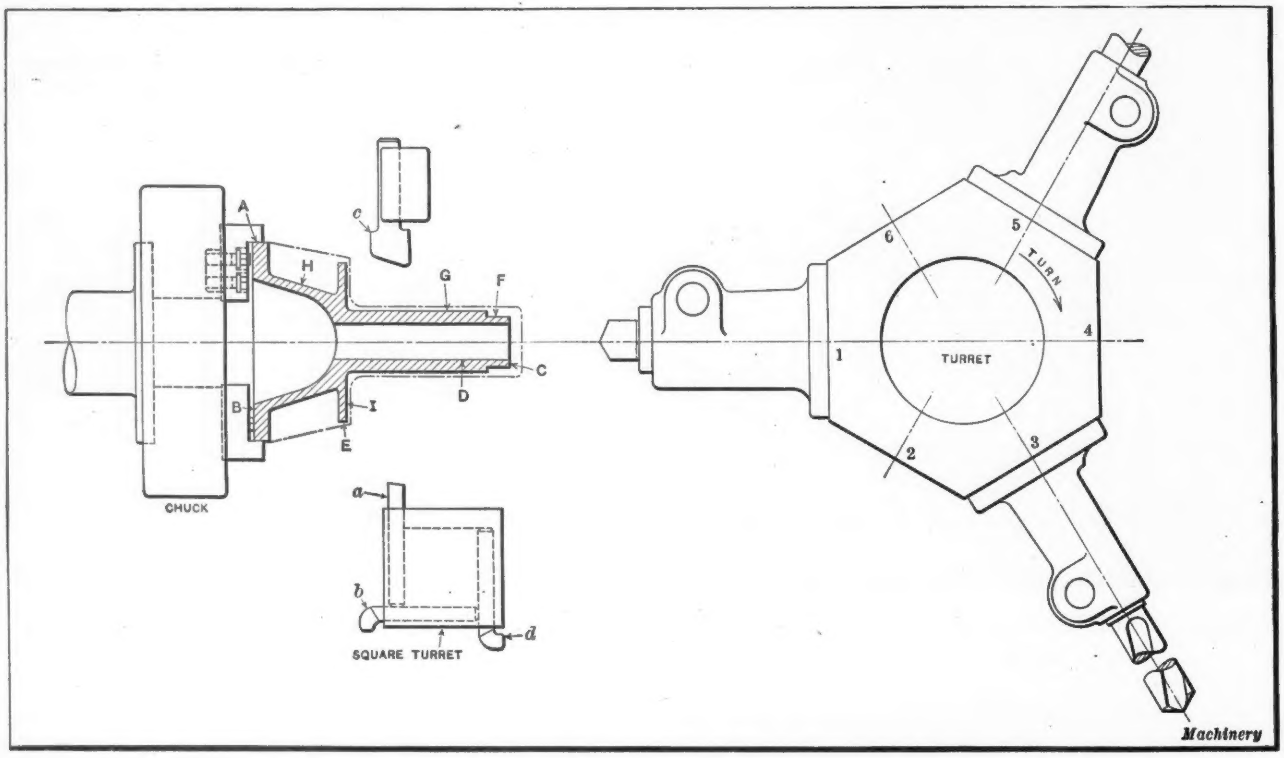


Fig. 2. Tooling Equipment employed in First Operation on Airplane Engine Nose-piece

The work is mounted on the machine in the manner just described. (2) Surface *B* is rough-faced; surface *K* is rough-turned; surface *L* is rough-faced; and surface *A* is rough-turned; all of these cuts being taken by tool *e* which is mounted in the square turret. (3) Hole *M* is rough-bored by the cutter held in the boring-bar mounted in the holder in Face 1 of the turret. This boring-bar is provided with a pilot which extends into a bushing in the machine spindle during the taking of this cut. (4) The internal taper surface *N* is gashed out by the stepped double-edged forming tool mounted in the holder in Face 2 of the turret. By referring to the end view of this tool shown at *f*, it will be seen that the device consists of two tools secured on opposite sides of a bar. Means are provided for adjusting these tools. The outer end of the tool-holder is provided with a hardened steel bushing *g* which extends into hole *M* when the tool on this tool-holder is being used. (5) Surface *N* is rough-formed by the forming tool mounted in the holder in Face 4 of the turret. This tool is similar to the one mounted in Face 2 of the turret except that the taper surfaces are not stepped. It is also provided with a pilot bushing. (6) Surface *B* is rough-faced; surface *K* is rough-turned; surface *L* is rough-faced; and surface *A* is rough-turned; all of these cuts being taken by tool *h* which is mounted in the square turret. This

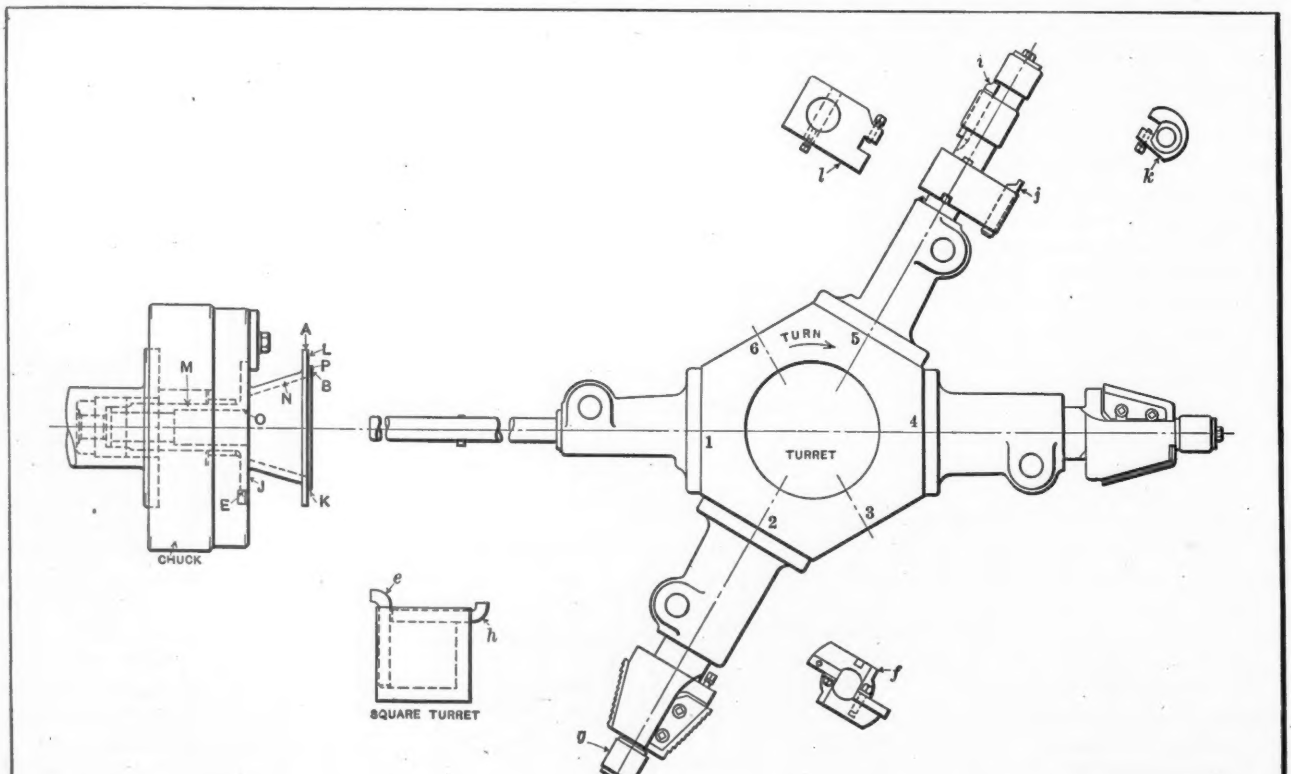


Fig. 3. Tool Lay-out used in taking Roughing Cuts on the Flange End of the Airplane Engine Part

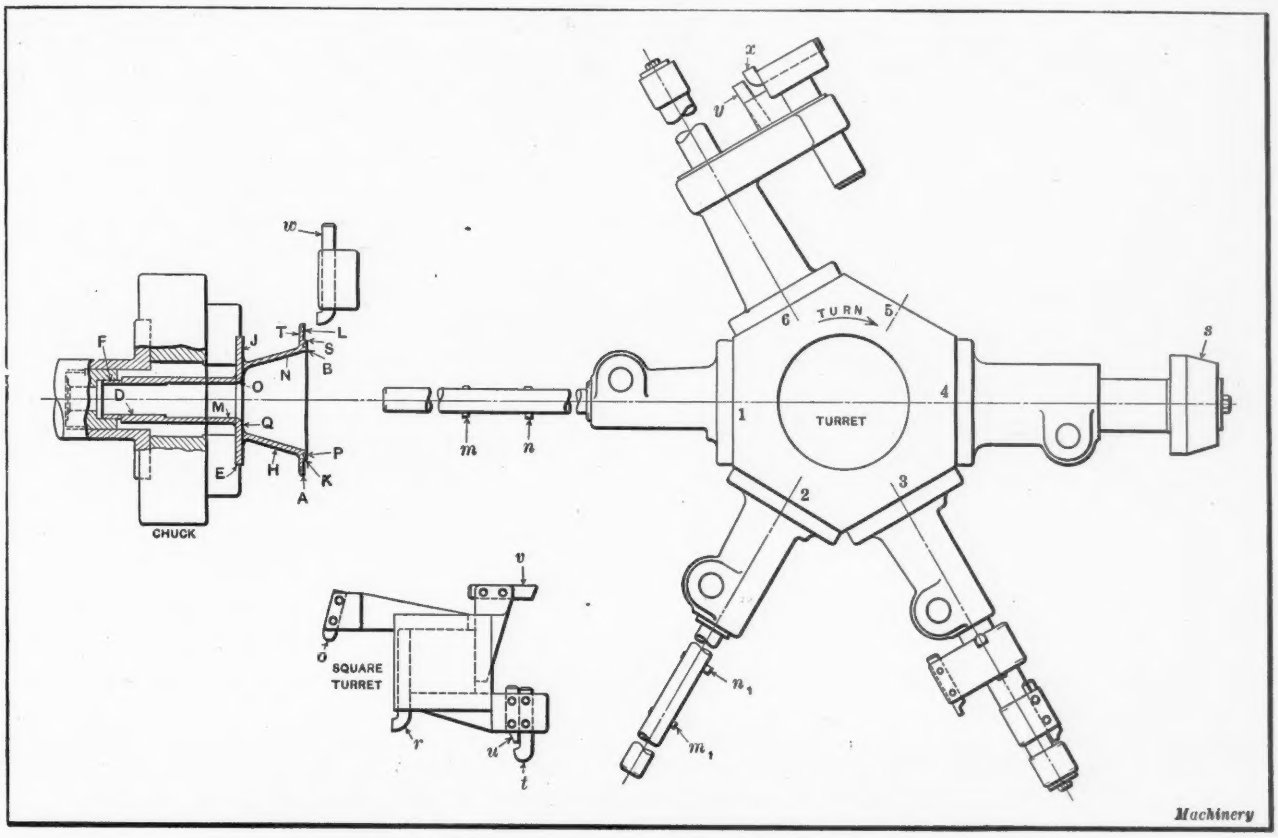


Fig. 4. Lay-out and Tooling Equipment used in Finishing Operation on the Flange End of the Nose-piece

tool is similar in shape to tool *e*. (7) Corner *O* is rounded by tool *i*, and recess *P* is rough-formed by tool *j*, these tools being held in the piloted tool-holder mounted in Face 5 of the turret. End views of the attachments provided for mounting these tools are shown at *k* and *l*.

Tool Lay-outs Used in Third and Fourth Operations on Nose-piece Forging

A lay-out of the tooling equipment used in the third operation on the forging is shown in Fig. 4. The successive steps performed in this chucking are as follows: (1) The work is mounted in a 15-inch Coventry chuck provided with suitable recessed soft jaws that grip the work around surface *E*. The small end of the forging is supported by means of surface *F* being inserted into a specially provided bushing in the end of the spindle. (2) Holes *D* and *M* are rough-bored by tools *m* and *n*, respectively, which are held in the boring-bar mounted in the holder in Face 1 of the turret. (3) Holes *D* and *M* are finish-bored by tools m_1 and n_1 which are mounted in the boring-bar held in Face 2 of the turret. (4) Surface *N* is finish-taper-bored by tool *o* which is mounted in the square turret and used in conjunction with a taper attachment, and surface *Q* is finish-faced by the same tool which is fed across surface *Q* by means of the cross-slide. (5) Surfaces *A* and *K* are rough-turned and surfaces *B*, *L* and *S* are rough-faced by tool *r* which is mounted in the square turret. (6) Corner *O* is finish-rounded and recess *P* is finish-formed by two separate tools mounted in the holder in Face 3 of the turret. These tools and the holder are similar in construction to those mounted in Face 5 of the turret, Fig. 3. (7) The revolving part *s*, mounted on the end of the attachment held in the holder in Face 4 of the turret, is inserted into the tapered surface *N* to provide means for supporting this fragile end of the work during the remaining steps performed in this chucking. (8) Surface *T* is finish-faced and chamfered at the outer end by tools *t* and *u* respectively, which are held in the square turret. (9) Surface *H* is finish-taper-turned by tool *v* which is mounted in the square turret and used in conjunction with the taper attachment, and surface *J* is finish-faced by the same tool. (10) Surfaces *B*, *L* and *S* are finish-faced and surface *K* is turned by tool *w* which is mounted in a tool-post on the rear of the cross-slide. (11) Surface *A* is finish-turned by tool *x*, and surface *K* is finish-turned by tool *y*, these two tools being mounted in the piloted tool-holder which is held in Face 6 of the turret, as shown.

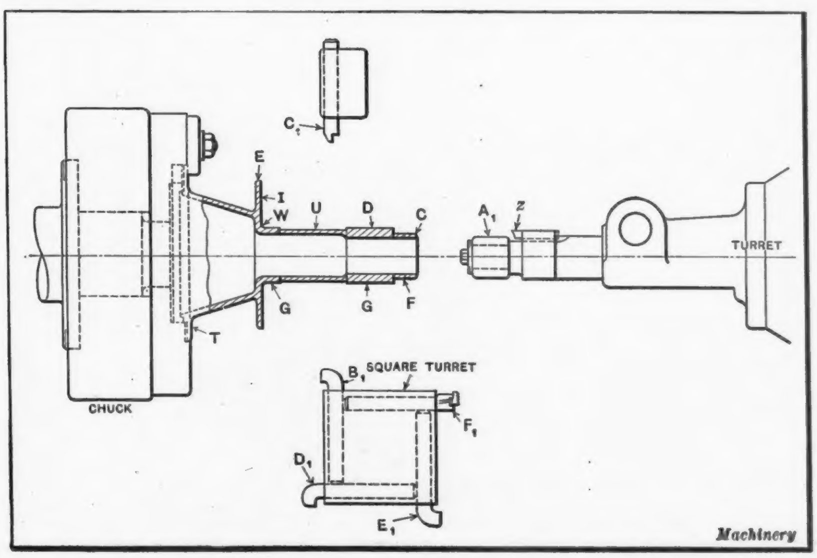


Fig. 5. Equipment provided for performing the Final Operation on the Engine Nose-piece

The final operation on the forging is performed with the tooling equipment that is illustrated in Fig. 5. The various steps in this operation are taken in the following order: (1) The work is held in a fixture in which it is seated by means of surface *K*, Fig. 1, and is held in place by clamps which bear against surface *T*. (2) Surface *C* is faced and chamfered by tool *z* which is mounted on a holder in the hexagonal turret. This tool-

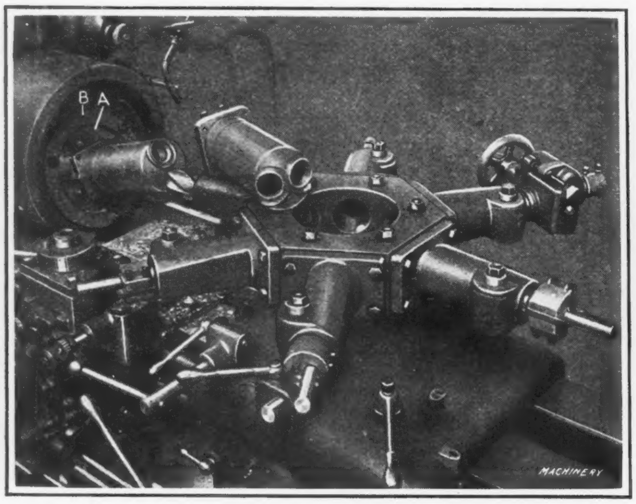


Fig. 6. Machine provided with Tools and Special Indexing Fixture required in machining the Cylinder Head of a Water-cooled Airplane Engine Cylinder

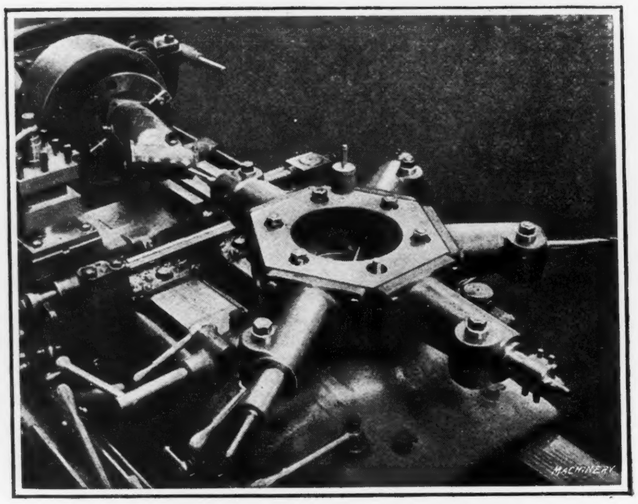


Fig. 7. Set-up of Tooling Equipment and Work on Machine employed in machining the Valve Guide Holes in the Airplane Engine Cylinder

holder is provided with bushing A_1 which is inserted into hole *D* during this and succeeding operations in order to support the work at the small end. (3) Surfaces *F*, *G*, and *E* are rough-turned and surface *I* is rough-faced by tool B_1 which is mounted in the square turret. (4) Surface *E* is finish-turned and rounded and surface *U* is finish-turned by tool C_1 which is mounted on a toolpost at the rear of the cross-slide. (5) Surfaces *G* are finish-turned; surface *I* is finish-faced; and corner *W* is finish-formed; all of these cuts being taken by tool D_1 which is mounted in the square turret. (6) Surface *F* is finish-turned by tool E_1 which is held in the square turret. (7) The threads on surface *F* are cut by the chasers held in tool-holder F_1 which is mounted in the square turret. (8) The completed part is finally removed from the lathe.

Indexing Fixture for Machining Bosses and Holes at an Angle in Cylinder Head

The machine shown in Fig. 6 is provided with the tooling equipment required in machining the holes and bosses in the head of a water-cooled airplane engine cylinder. These bosses and holes are at an angle with the center line of the cylinder, their axes intersecting on the cylinder center line on the inside of the cylinder. For this reason it was necessary to develop a special indexing fixture in order to bring the center lines of these bosses into alignment with the

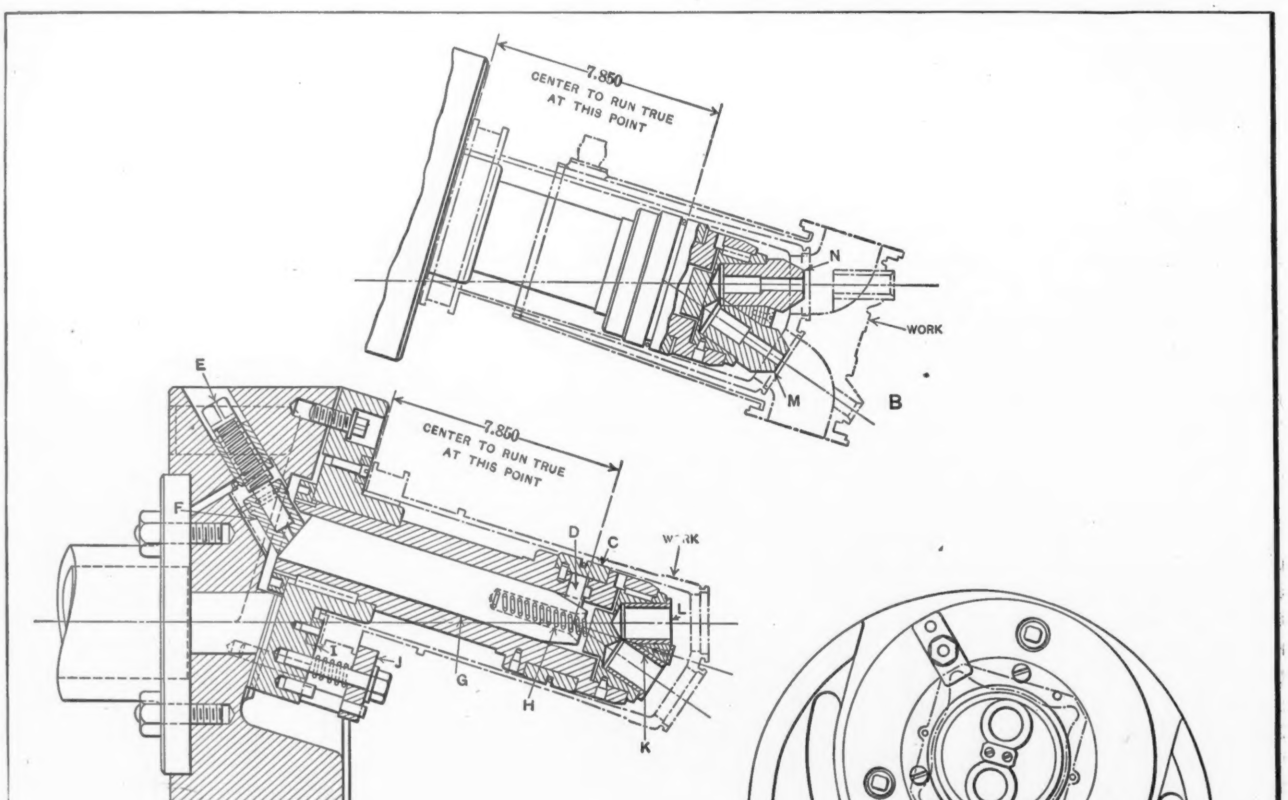


Fig. 8. Special Indexing Fixture provided for machining the Holes in the Cylinder Head at an Angle with the Center Line of the Cylinder

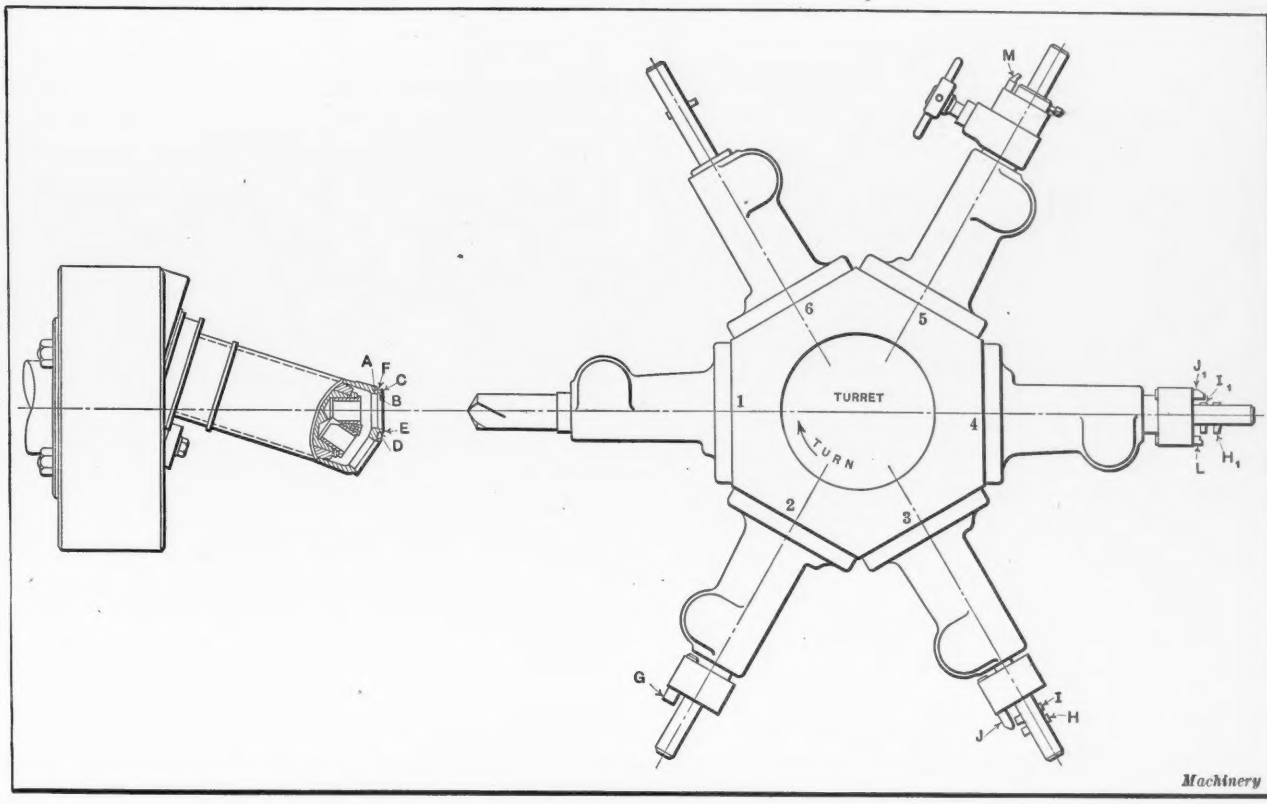


Fig. 9. Lay-out of Tools provided on Turret Lathe for machining the Holes and Bosses on the Head of the Cylinder preparatory to welding the Valve Boxes in Place

tools in the turret during the operations performed on them. The fixture is inclined at the same angle with the spindle of the machine as the axes of the bosses are in relation to the center line of the cylinder, so that after one boss has been placed in position for the operation, it is only necessary to revolve the fixture through 180 degrees in order to bring the other boss into the correct machining position.

A sectional view of a fixture which differs slightly from the one shown on the machine in Fig. 6, is shown in Fig. 8; however, the general principles are the same. The work is placed on the fixture in the manner indicated by the dot-and-dash lines at *A*, being held in the fixture by means of the pressure exerted on the cylinder bore by the split bushing *C* as it is forced radially outward from the center of the mandrel by several pins *D*. This occurs when screw *E* is tightened, which causes the wedge-shaped piece *F* to act upon the end of plunger *G*, thus forcing it forward. Plunger *G*, in turn, forces pins *D* outward by means of the taper surface on the end of the plunger which is in contact with inclined surfaces on the ends of the pins. When screw *E* is loosened the plunger is forced back by the expansion coil spring *H*, which is held in a hole drilled in the front end of the plunger.

In locating the work on the fixture for the machining operation, use is made of two accurately spaced dowel holes which have previously been machined 180 degrees apart through the flange of the cylinder in order to provide means for locating the cylinder on the crankcase. These holes are of two different sizes, and the small one is utilized in locating the cylinder for machining the first hole and boss. Plate *I* is provided with a pin which is inserted into this dowel hole, after which clamps *J* are tightened, thus holding the work in place. After the first hole and boss have been machined, clamps *J* and screw *E* are loosened and the cylinder is revolved approximately 180 degrees. The actual location of the second boss is accomplished by inserting a hardened plug through the machined hole in the first boss into the bushing which happens to be in the same position as bushing *K* in the illustration. When the cylinder is in this position the pin in plate *I* will be in the largest dowel hole in the cylinder flange, which on account of its size, does not influence the position of the cylinder. On the machine shown in Fig. 6, the work is indexed by revolving plate *A* on which the cylinder is mounted, through 180 degrees. This plate is placed eccentrically with the machine spindle, and the correct position is determined by means of a spring plunger. The fixture is then clamped in the desired position by means of the circular gib *B*.

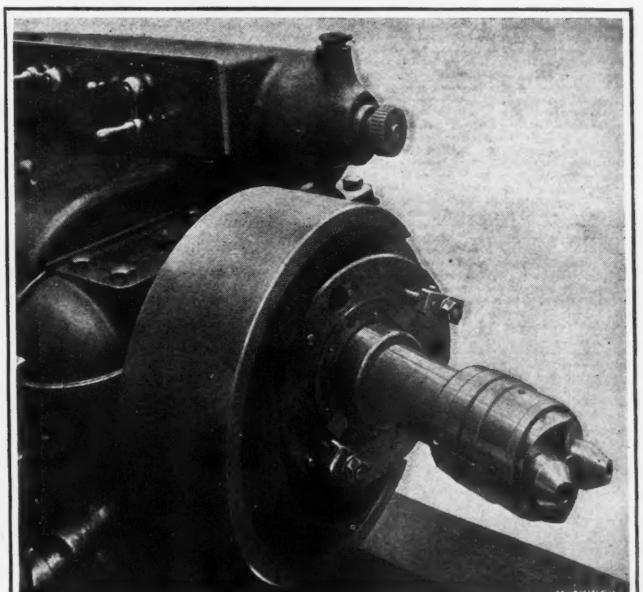


Fig. 10. Close-up View of Machine provided with Inclined Fixture used in machining the Valve Guide Holes

Tool Lay-out Employed in Machining Cylinder Head Bosses and Holes

The tooling equipment with which the machine shown in Fig. 6 is provided, is illustrated in Fig. 9. The various steps in this operation are taken in the following procedure: (1) The work is placed on the fixture in the manner previously described. (2) A hole is drilled through one of the bosses by the drill mounted in Face 1 of the turret. (3) Surface *C* is rough-faced by tool *G* which is held in the tool-holder

mounted in Face 2 of the turret. This tool-holder is provided with a pilot which extends into the bushing which happens to be in the position indicated by bushing *L* in Fig. 8, while taking this cut. (4) Hole *A* and counterbore *B* are bored by tools *H* and *I* respectively; and surface *D* is turned by tool *J*, these tools being held in the tool-holder mounted in Face 3 of the turret. (5) Hole *A* and counterbore *B* are finish-bored by tools H_1 and I_1 respectively; surface *D* is finish-turned by tool J_1; and chamfer *E* and surface *C* are finish-faced by tool *L*, these tools being held in the tool-holder in Face 4 of the turret. (6) Recess *F* is formed by tool *M* held in the special slide tool mounted in Face 5 of the turret. (7) Hole *A* is finish-bored by the tool held in the piloted boring-bar mounted in Face 6 of the turret. After these steps have been performed, the cylinder is indexed in the manner previously described and similar cuts are taken on the second boss and hole in the cylinder head.

Machining Valve Guide Holes in the Cylinder Head

After the foregoing operation is performed on the cylinder head, the water jacket is fitted to the cylinder and the valve-boxes are welded in counterbores *B*, Fig. 9, as indicated by the dot-and-dash lines at *B* in Fig. 8. The cylinder is then mounted on the fixture as shown at *B* in order to machine the valve guide holes. The only difference between the fixture as shown at *B* from the way it is shown at *A* is that bushings *K* and *L* at *A* have been replaced by bushings *M* and *N* in order to accommodate the smaller boring-bar pilots used in machining the valve guide holes. The first position of the cylinder is determined by the pin in plate *I* and the dowel hole in the cylinder flange as previously described. The second position is determined by inserting a hardened plug through the hole finished in the first part of the operation, and into the bushing which is in the position indicated by bushing *M*. This is identical with the method used in locating the cylinder for the second portion of the operation shown at *A*. Fig. 10 shows a close-up view of a machine provided with the inclined indexing fixture that is used in this operation.

The tooling equipment used in finishing the valve guide holes is illustrated in Fig. 11. The successive steps in this operation are taken as follows: (1) The work is located on the fixture in the manner just described. (2) Hole *A* is rough-drilled by the straight-fluted drill mounted in Face 1 of the turret. This drill is supported during this step by the steady bar *C* which is mounted in the square turret. (3) Hole *A* is chamfered at its outer end by tool *D*, and surface *B* is finish-faced and chamfered by tool *E*, these tools being mounted in the holder in Face 2 of the turret. This holder is also provided with a pilot *F* which extends into the bushing that happens to be in the position indicated by bushing *N*, Fig. 8, while the cuts are being taken. (4) Hole *A* is rough-taper-reamed by the stepped reamer held in the holder mounted in Face 3 of the turret. (5) Hole *A* is finish-taper-reamed by the finishing reamer held in the holder mounted in Face 4 of the turret. After these cuts have been taken, the cylinder is indexed in the manner previously mentioned and the second hole is machined similarly to the first hole. A machine engaged in one of the reaming steps is shown in Fig. 7, this machine being provided with the indexing fixture shown in Fig. 8 and the tooling equipment illustrated in Fig. 11.

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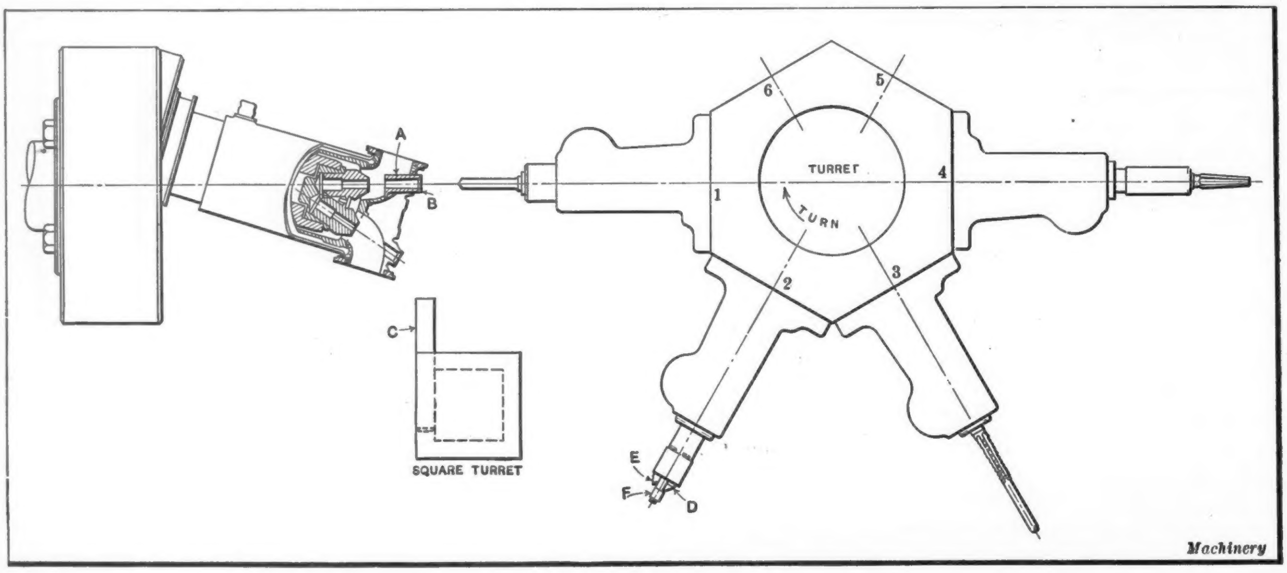


Fig. 11. Tooling Equipment provided for machining the Valve Guide Holes in the Airplane Engine Cylinder Head

MEASURING WORM AND ACME THREADS

By THOMAS A. REILLY

In connection with the article on page 1131 of the August number of MACHINERY, "Three-wire System for Measuring Standard Worm Threads," the writer would refer those interested in a complete study of the subject to the several pamphlets on thread measurements that have been published by the Bureau of Standards. A word of caution should also be given in regard to the use of the method proposed in the article in the August number, because the method explained is approximate only, and while nearly enough correct for practical purposes when the helix angle is not too steep, there are cases when, on account of the steepness of the helix angle the accuracy required in the work may not permit of the use of the method explained. It would be difficult, if not impossible, to give a general rule to determine when corrections should be made for the helix angle, as this depends largely on the nature of the work, and while the writer would like to see a simple correct method of calculating these measurements, it seems that no reasonably simple method can be proposed that would take in all the factors. Nevertheless, a word of caution in regard to the fact that the method proposed has limitations is not out of place.

* * *

The importance of forwarding shipping documents promptly when shipping goods to Australia is emphasized in a recent commerce report. The Australian Department of Trade and Customs has stated that failure of shipping documents to arrive in Australia by the time the goods reach that country has resulted in a decision that after January 1, 1921, goods will not be delivered until the documents are received. Only in exceptional cases will any deviation from this rule be made, and even then an extra duty of at least 50 per cent of the ordinary duty will be required, pending the submitting of the complete documents.

Stresses in Brackets and their Bolts

By VICTOR M. SUMMA, Engineering Examiner, American Brake Co., St. Louis, Mo.

THE design of malleable-iron or cast-steel brackets and their fastening bolts is often the result of individual opinion and "rule-of-thumb" methods rather than the outcome of a scientific investigation of the forces acting upon them. There is, however, very little justification for employing guesswork methods, especially as the scientific method is simple and in the majority of cases results in the production of brackets having greater strength for their weight than would otherwise be the case.

In Fig. 1 is shown an ordinary bracket designed to support a load W suspended from a pin of diameter D at a distance l from the back and lower edge of the casting. As the tendency of the bracket is to turn about point O the bolts will be subjected to tensile stress as well as shearing stress. It is clear that while the upper bolts will resist a total shearing force Q equal to that of the lower bolts, the total pulling force on each set of bolts is necessarily unequal, so that the value of P is different from that of R. The strain of the top bolts is greater than that of the lower bolts in proportion to their distances m and n from O. Therefore, if P stands for the total stress of the upper bolts, the stress R of the lower ones will be $\frac{n}{m}P$ or $R = \frac{n}{m}P$. It is evident that to maintain equilibrium the following relation between the moments of W, P, and R about O must exist:

$$Wl = Pm + \frac{nP}{m}n = P\left(m + \frac{n^2}{m}\right) = P\left(\frac{m^2 + n^2}{m}\right)$$

from which it follows that:

$$P = \frac{Wl}{m^2 + n^2}m, \text{ and } R = \frac{n}{m}P = \frac{Wl}{m^2 + n^2}n$$

As these formulas give the tension forces acting on the bolts, the unit stress can now be determined if the diameter of the bolts is given. Since these stresses are normal to the shearing unit stresses of the forces Q, their combined effect can be determined by means of formulas:

$$P_1 = \frac{S}{2} + \sqrt{\left(\frac{S}{2}\right)^2 + S_s^2}, \text{ and } P_2 = \sqrt{\left(\frac{S}{2}\right)^2 + S_s^2}$$

in which

S = unit tensile stress;

S_s = unit stress in shear;

P_1 = maximum resultant in tension;

P_2 = maximum resultant in shear.

In order to analyze the stresses in the material of the bracket, it is necessary to draw the bending moment diagram shown in Fig. 2. It will be noted that the moment Wl in this diagram has been replaced by couple FF. This substitution is necessary in order to ascertain where the bending effect of Wl on the casting is the greatest, which of course depends on the location of the pin with respect to the bolts. As to the points of application of force FF it is reasonable to assume them to be applied at the top h and bottom k, respectively, of the pin having a diameter D, since it is at these places that the pin must react in order to resist the turning moment of load W. The intensity of force F is given by the equation $FD = Wl$, and is therefore equal to Wl divided by D.

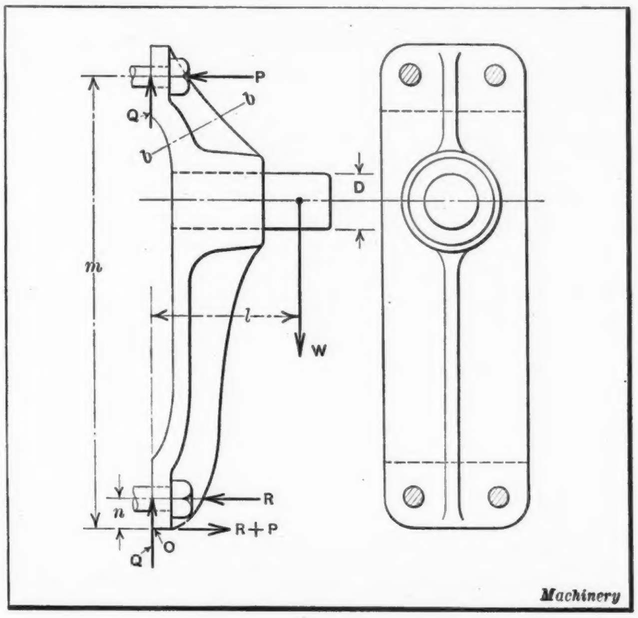


Fig. 1. Bracket designed to support a Weight W at a Distance l from the Wall

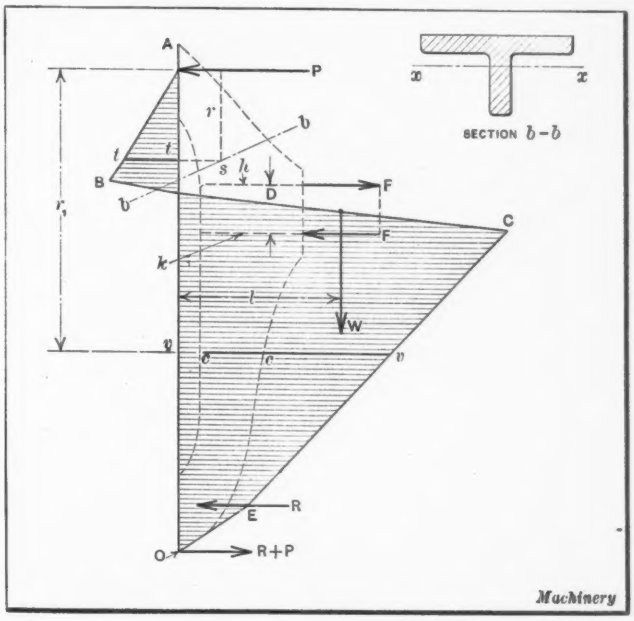


Fig. 2. Bending Moment Diagram for the Bracket illustrated in Fig. 1

The external forces can now be calculated from the foregoing equations, and as they are perpendicular to the straight line AO the bending moment diagram can be readily drawn by the usual method. In Fig. 2 the shaded area represents such a diagram in which lines such as vv and tt, for instance, represent to a given scale the bending moments at sections c-c and b-b, respectively of the casting, the straight line AO being the origin of the lines, and the broken line $ABCEO$, the line drawn through the end of each moment line.

Assume now that the view in the upper right-hand corner of Fig. 2 shows the section of the casting at b-b and that it is required to find the maximum stress of this section. It is first necessary to calculate the modulus of section Z with respect to the neutral axis x-x, about which the resisting fibers of the material tend to revolve. If r is the perpendicular distance of the center of gravity s from the line of action of the force P, then the bending moment to which the section is subjected is $P \times r$, the value of which is represented on the diagram by line tt. The maximum stress S

(when Z is the minimum value) is $S = \frac{Pr}{Z}$.
From the diagram it is evident that this stress is tensile and that it occurs at the rib of the bracket.

Calculating Stresses in Bracket Bolts

The following example illustrates the method of determining the stresses in bolts which are employed in fastening brackets such as the one shown in Fig. 3 by substitution in the preceding formulas for the values of P and R:

$$P = \frac{25{,}000 \times 8}{22^2 + 1.25^2} \times 22 = 9100 \text{ pounds}$$

approximately

$$R = \frac{25{,}000 \times 8}{22^2 + 1.25^2} \times 1.25 = 516 \text{ pounds}$$

which shows that each of the top bolts carries a load of one-half of 9100 pounds or 4550 pounds in tension, besides one-fourth of 25,000 pounds or 6250 pounds in shear, and that they are the bolts liable to be overstressed. The maximum stresses due to the combined effect of the forces of 4550 pounds and 6250 pounds are

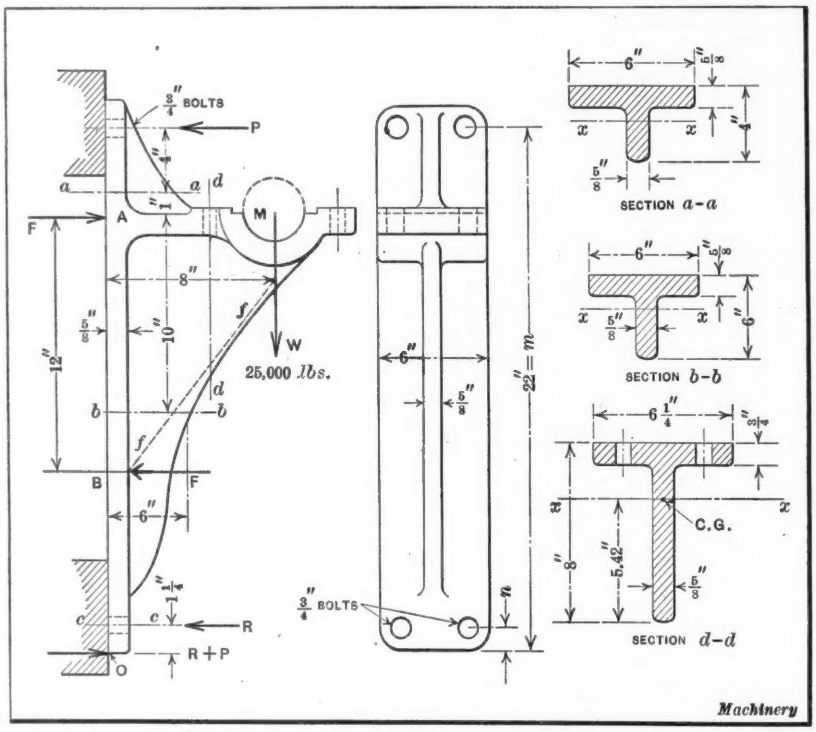


Fig. 3. Bracket designed to support a Weight of 25,000 Pounds at a Distance of 8 Inches from the Wall

$$\text{Tension } P_1 = \frac{4550}{2} + \sqrt{2275^2 + 6250^2} = 8920 \text{ pounds.}$$

$$\text{Shear } P_2 = \sqrt{2275^2 + 6250^2} = 6650 \text{ pounds}$$

or dividing the results thus obtained by 0.4418 (which is the sectional area of a ¾-inch bolt) the corresponding unit stresses are found to be 20,100 pounds and 15,100 pounds per square inch respectively. From these results, it is evident that the size of the top bolts should be increased from ¾ to ⅞ inch in order to give the required strength.

Calculating Stresses in Brackets

In regard to the analysis of the stresses in the casting forming the body of the bracket shown in Fig. 3 it is first necessary to consider what action the hypothetical couple FF is likely to have. From the illustration it is evident that the force W has a tendency to put the fibers from A to M in tension, or to exert a pull at A while the fibers along ff will be in compression or cause a thrust at B. The arm of the couple may be assumed to be 12 inches in length and the following equation obtained:

$$F \times 12 = 25{,}000 \times 8$$

and

$$F = \frac{25{,}000 \times 8}{12} = 16{,}660 \text{ pounds}$$

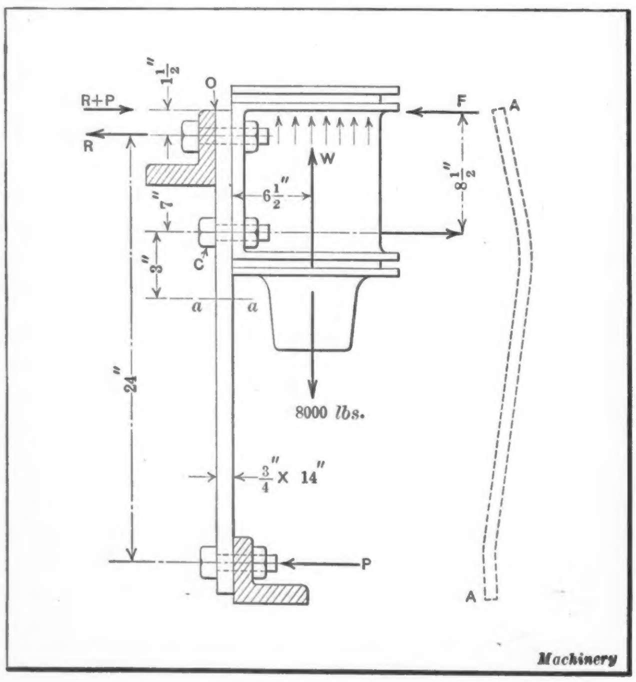


Fig. 4. Diagram showing how Force exerted on Piston of Air Cylinder acts on Plate to which Cylinder is attached

As the bending moment at a given cross-section is the algebraic sum of the moments of the forces on one side of the section, the stresses at section a-a (the section modulus of which is 2.5) are:

$$S = \frac{9100 \times 4}{2.5} = 14{,}500 \text{ pounds per square inch in tension}$$

or compression.

The stresses at section b-b (the section modulus of which is 5.7) are:

$$S = \frac{9100 \times 15 - 16{,}660 \times 10}{5.7} = 5400 \text{ pounds per square}$$

inch in compression.

The stresses at section c-c can now be calculated (taking into consideration the fact that $R + P = 516 + 9100 = 9616$)

$$S = \frac{9616 \times 1.25 \times 6}{(6 - 1.5) \times (0.625)^2} = 40{,}600 \text{ pounds}$$

in tension or compression which shows that the bracket is liable to break at this point and that the rib should reach down to the edge, or that the thickness should be increased at this point.

In calculating the stresses at section d-d (the center of gravity of which is 3½ inches from the line of action of the load) it is necessary first to calculate the least section modulus and the maximum section modulus. By calculation, these are found to be 9.7 and 20.5, respectively. Hence, the stresses due to the bending moment are:

$$S = \frac{25{,}000 \times 3.5}{20.5} = 4260 \text{ pounds per square inch}$$

which is evidently a tensile stress that occurs at the back of the casting; and

$$S = \frac{25{,}000 \times 3.5}{9.7} = 9000 \text{ pounds per square inch}$$

which is a compressive stress, and occurs at the front portion of the rib. The shearing stress is, of course, equal to the load divided by the area of the section and equals

$$\frac{25{,}000}{8.27} = 3020 \text{ pounds per square inch}$$

This analysis shows that the bracket is amply strong at this section.

Stresses in Simple Plate

In Fig. 4 is shown a cylinder which is attached to a 14-inch by ¾-inch plate by means of four bolts. Assuming that plate and cylinder are integral parts of each other, let it be required to find the stress in the supporting plate at a section *a-a*, 10 inches from the top bolts.

In this case the effect of the air pressure is an upward force whose turning moment about edge O is equal to 8000 $\times$ 7.25 inch-pounds. Therefore the resisting forces at the bolts through the angles are:

$$P = \frac{8000 \times 7.25}{(25.5)^2 + (1.5)^2} \times 25.5 = 2270 \text{ pounds}$$

$$R = \frac{8000 \times 7.25}{(25.5)^2 + (1.5)^2} \times 1.5 = 133 \text{ pounds}$$

Since the turning effect of the cylinder produces a couple FF acting at O and at the bolts C with an arm equal to 8½ inches

$$F \times 8.5 = 8000 \times 7.25$$

or

$$F = \frac{8000 \times 7.25}{8.5} = 6820 \text{ pounds}$$

Hence the bending moment M at the section *a-a* is the algebraic sum of the moments of all the forces on one side of it, or

$$M = P\ (24 - 10) = 2270 \times 14 = +\ 31{,}700 \text{ inch-pounds}$$

The accuracy of this value may be checked by taking the algebraic sum of the moments on the other side which equals:

$$-\ [F - (P + R)] \times 11.5 - R \times 10 + F \times 3$$
$$= -\ [6820 - 2403] \times 11.5 - 133 \times 10 + 6820 \times 3 =$$
$$-\ 31{,}700$$

Dividing this by the modulus of section of the plate with regard to the neutral axis in the direction of its width, the stress at *a-a* in tension or compression, is:

$$S = \frac{31{,}700 \times 6}{14 \times (0.75)^2} = 24{,}000 \text{ pounds per square inch}$$

The view *A-A* at the right gives an idea of the shape the plate is liable to take under excessive load. In conclusion it may be noted that the section *a-a* in this example, as well as *a-a*, *b-b*, and *c-c* in the preceding example, is subjected to flexure stresses only; and that the seemingly direct stress due to the pulling effect of W is counteracted in its effect by the opposite resistances of the bolts. In other words, these brackets which at first glance might be looked upon as struts—and analyzed as such—have very little or nothing in common with them.

* * *

REPAIRING LARGE STEAM HAMMER COLUMN

An unusual repair job on a large steam hammer column is described by John W. Weida, night superintendent of the Canton Drop Forging & Mfg. Co., Canton, Ohio, in a recent issue of *Reactions*. The weld was performed on the column of a 3000-pound steam hammer, the column being made from a hollow steel casting, with walls varying from 1½ to 2½ inches in thickness. The column was broken clear across and was repaired by thermit welding. To perform the work, the hammer was dismantled and an opening of 2½ inches between the two fragments of the column was cut out with an oxy-acetylene torch. Then the required mold was made around the weld, and 450 pounds of railroad thermit poured into it. The weld proved very successful.

ALUMINUM ALLOYS FOR CASTINGS AND FORGINGS

Experiments and researches in regard to the alloying of various chemical constituents and metals with aluminum, to produce better castings and forgings, have been conducted by the Lynite Laboratories, Cleveland, Ohio. The results obtained were recently discussed in a paper presented before the Indiana Section of the Society of Automotive Engineers by R. E. Carpenter, manager of the laboratories. Prior to the experiments, the effect of slight changes in the chemical constituents upon the standard alloys generally used had not been considered to any extent. The standard 92-8 aluminum-copper or No. 12 alloy was used almost exclusively. The first experiments included a careful study of the effect of slight changes in the percentages of the constituents as well as the results secured by adding other metals.

Production of New Alloys

The first important result was the production of the Lynite No. 112 alloy which is the original No. 12 alloy with slight additions of other metals. The desirable casting characteristics are not materially different from those of the earlier one, but a decided improvement in the physical properties is effected; in fact, there is an improvement of approximately 15 per cent. Alloy No. 112 was used extensively in producing Liberty engines. The minimum standards used by the inspection department of the Government for these parts allowed castings to pass inspection having a tensile strength of only 16,000 pounds per square inch, and an elongation of 1 per cent. Even at this low mark, many castings did not meet the specifications. However, the No. 112 alloy proved very satisfactory, as only three of the test bars taken from all the castings produced failed to attain this minimum tensile strength, and these failed by only a few hundred pounds. A great many of the castings had a tensile strength of 24,000 pounds per square inch.

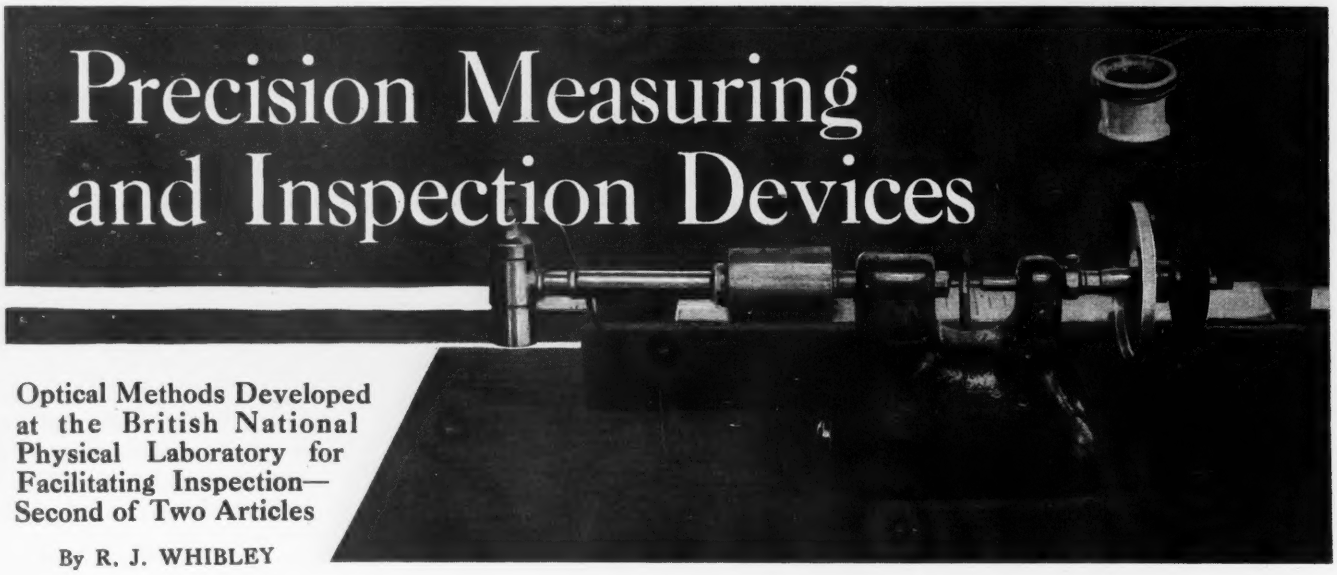
The next improvement was the No. 112-B alloy. Castings made from this alloy have an average tensile strength of between 19,000 and 21,000 pounds per square inch, with an elongation of from 1½ to 2 per cent, in standard test bars. Even with these physical properties, aluminum is only comparable with an ordinary grade of cast iron, except with respect to elongation. In an endeavor to develop a better material, 1000 or more alloys covering compositions of aluminum-copper, aluminum-zinc, and aluminum-zinc-copper, with other added constituents were made and tested. As a result of this research, the high-tensile-strength alloy No. 145 was evolved. This alloy has an average tensile strength of 27,500 pounds per square inch and an average elongation of 4.5 per cent. The combination of these two desirable qualities provides an excellent casting alloy which makes possible the use of aluminum alloys in parts previously made of malleable iron. It also permits the reduction of the sections of some castings to the point where the only limit is the ability to pour them satisfactorily in the molds. The specific gravity of this alloy is only 2.92; alloys having a specific gravity exceeding 3 are usually high in zinc and have not been found reliable.

Perhaps the most sensational result in the experiments was the development of a forging alloy having a tensile strength of from 55,000 to 65,000 pounds per square inch, an elongation of from 18 to 22 per cent and a reduction in area of from 38 to 40 per cent. The process followed in making such forgings involves working the material under accurately controlled temperatures and giving careful heat-treatments after forging.

* * *

The total working population of the United States is forty million people, according to statistics printed by the Department of Labor. The labor turnover is estimated to be about 25 per cent, and the cost of hiring and discharging employes is approximately two billion dollars per year.

Precision Measuring and Inspection Devices



Optical Methods Developed at the British National Physical Laboratory for Facilitating Inspection—Second of Two Articles

By R. J. WHIBLEY

THE first article on this subject described attachments used in connection with the Newall measuring machine and also dealt with various other optical devices used in connection with measuring and testing. The present article will deal with the minimeter and with the gage comparator used by the National Physical Laboratory for inspecting precision gage-blocks, by means of which it is claimed that readings to an accuracy of one millionth of an inch can be made.

The Minimeter

It has become necessary when inspecting precision gage-blocks to use measuring machines which are more highly sensitive than the standard machines of this type. Obviously it is useless to attempt to verify the accuracy of a statement that a gage-block is correct to 0.00001 inch if the measuring machine used is not capable of detecting differences greater than this magnitude.

The most important requirement of any comparator or measuring machine is that it must be independent of the operator as regards variations in reading for the same piece. The machines that are now in use at the National Physical Laboratory for inspecting precision gage-blocks give successive readings to an accuracy of one-millionth of an inch. In these a new principle has been adopted in that the moving anvil does not slide in a fitted hole but is attached to a fixed part of the machine by flexible steel strips, thus avoiding many errors that arise when sliding fits are used. The first machine made is illustrated in Fig. 13, while Fig. 11 shows the mechanical arrangement of the instrument proper. On the bed *A* a fixed block *B* is secured, on an extension of which the adjustable anvil *D* is mounted. The face of the anvil is novel, the usual flat being replaced by three small steel balls soldered in position, so that a three-point contact is established on the surface of the gage. The moving anvil is provided with one larger ball *E*, which is secured to block

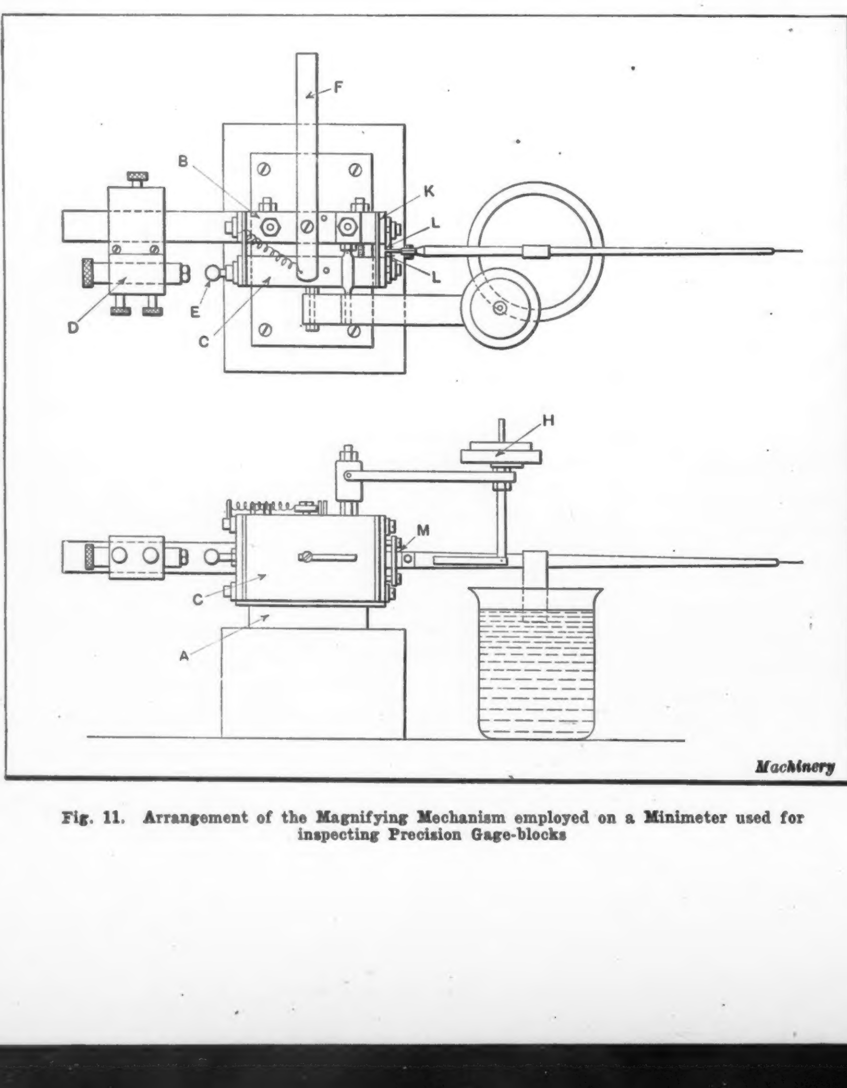


Fig. 11. Arrangement of the Magnifying Mechanism employed on a Minimeter used for inspecting Precision Gage-blocks

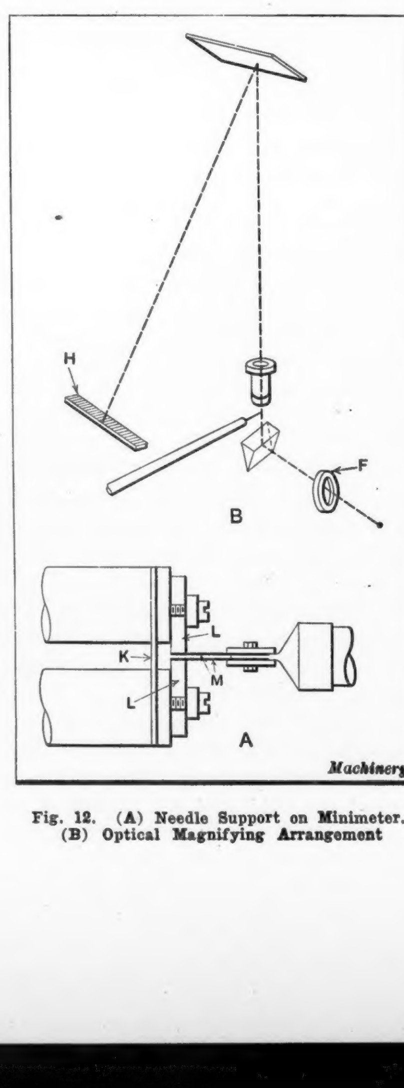


Fig. 12. (A) Needle Support on Minimeter. (B) Optical Magnifying Arrangement

C, which with B forms a pair of blocks slightly separated. The ends of the blocks are connected by two vertical strips of steel. The lower part of Fig. 12 shows an enlargement of the needle end of these blocks and their connections, one of the steel strips being seen at K. By means of these flexible strips movable block C can move in relation to the fixed block, a distance of about 0.0003 inch, the travel being limited by adjustable stops. Each block carries at the end, two small plates L to the inner edge of each of which a very thin strip M is attached. A small clamp holds the outer ends of these strips with a distance piece 0.02 inch thick between them, the clamp being formed with a socket into which a pointer 10 inches long is fitted, the heel of this pointer only being visible in the enlarged view. The pointer is made from a twisted quill of tin foil with an ordinary needle inserted at the pointing end. A small piece of foil attached to the needle extends down and just dips into a basin of water for the purpose of retarding the pointer movement.

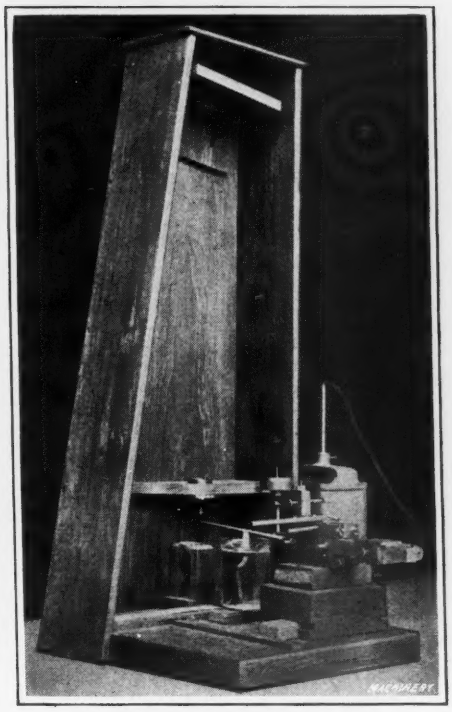


Fig. 13. Original Design of Minimeter constructed and used in the National Physical Laboratory, England

It will be obvious that any relative movement between the blocks B and C, Fig. 11, will cause the thin strips K to move relatively also, causing the pointer to swing. A movement of 0.00001 inch between the blocks causes the end of the pointer to move through 0.0035 inch, that is, a mechanical magnification of 350. For inserting the gage, the movable block is slightly retracted by the lever F, the travel of the block being limited in each direction by suitable stops. The steel strips by which the blocks are connected are not stiff enough to maintain a sufficient pressure on the gage-blocks under examination, and therefore the pressure is augmented by a weight H which operates through a parallel motion, the upper horizontal link of which is pivoted to a fixed portion of the instrument and the lower link to the movable block. The system multiplies the pressure by 2 so that an 8-ounce weight produces a pressure of 1 pound.

The travel of the end of the pointer is not read directly but is optically magnified. The diagram of the arrangement is shown at B, Fig. 12, and it will be seen that light from a "Point-o-lite" lamp is rendered parallel by a condenser lens F, after which it passes through a right-angled reflecting prism and illuminates the field traversed by the pointer. An image of the pointer is formed by the lens which appears on the scale H after reflection from an overhead mirror. When the image of the needle moves through 0.18 inch, the blocks have moved 0.00001 inch relatively to one another, the combined optical and mechanical magnification being 18,000. The scale is calibrated so that successive lines read differences of 0.00001 inch, each division being sufficiently large so that it may be subdivided by estimation to 0.000001 inch.

It is interesting to note that so far as the mechanical parts of the apparatus are concerned, the device does not call for any specially accurate workmanship; in fact, the sample in use was made in the workshop of the laboratory in a few hours. The three-point ball contact on one side of the gage and the single-point ball contact on the other, surmounts the difficulty usually experienced in making a pair of flat surfaces parallel with and perpendicular to the movement. Any small amount of dirt or grease does not affect the readings so readily, as four contact points quickly settle down and the creeping reading associated with flat surfaces which are not perfectly clean does not exist.

With this simple machine it is possible to compare two complete sets of blocks (excluding 2-inch, 3-inch and 4-inch sizes) to an accuracy of 0.000001 inch in nine hours. Three readings are taken on each gage and all the combinations are repeated as a check. With the ordinary measuring machine such an undertaking required seventeen hours, and the measurements were accurate only to 0.00001 inch.

Machine for Testing Precision Gage-blocks

The latest machine in use at the laboratory for testing precision gage-blocks is shown in Fig. 14. This machine was designed by J. E. Sears, the present head of the metrology department, and contains many ingenious features. The bed carries two heads, the right-hand one having an accurate bore, 1 1/4 inches diameter, accommodating a sliding spindle lapped to fit, which can be clamped in any convenient position. The left head is secured to the bed, and carries the moving anvil, the magnification of the movement being, as before, partly mechanical and partly optical. A gage-block is seen in position between the measuring faces.

The mechanism of the instrument is shown in Fig. 15. It will be seen that the measuring face of the moving anvil, which is 1/4 inch in diameter, is on the end of a spindle which extends to the rear of the head, the spindle having at its forward end a collar with a spherical under surface which is held in a beveled hole in the headstock barrel by a compression spring. The rear end of the spindle is held by four screws radially arranged, the housing carrying the screws being slotted in four places. It will be seen in Fig. 16 at A, that one of these slots is deeper than the other three. The slots enable the adjustable measuring face to be brought into a position square with the axes of the heads and parallel with the fixed measuring face, since the fixed face was lapped in a special jig carrying the lapped adjustable spindle. The reason for making one of the slots deeper than the others is to supply a varied springy resistance to the adjusting screws in the housing, so that by tightening one of the screws the opposite screw is pushed away an amount

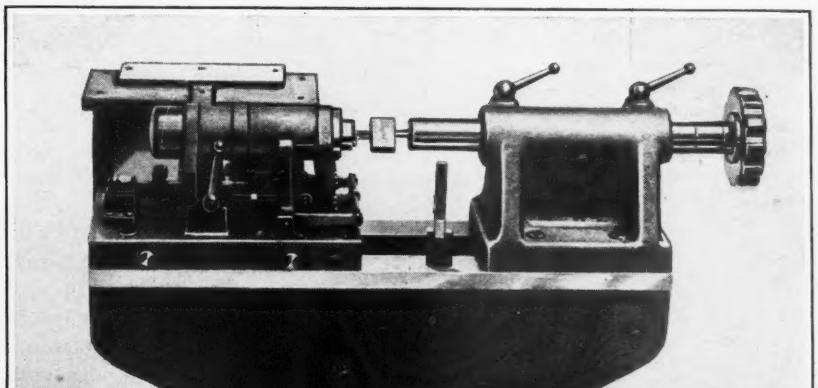


Fig. 14. Latest Type of Machine used for comparing Precision Gage-blocks up to Four Inches in Size

depending upon the stiffness of its support, the differential effect resulting in a very accurate adjustment of the measuring face.

General Arrangement

The movable barrel is secured to the fixed headstock by three flexible steel spring supports, one at the front and two at the rear. A lever seen in front of the left end of the barrel in Fig. 14 rotates a small cam which then bears on the rear leg of the barrel, as at *A*, Fig. 15, and retracts the measuring faces slightly for the insertion of the gages. The cam is then reversed to release the barrel, and the weight shown in Fig. 15, acting through the bellcrank and push-pins, maintains a constant pressure on the gage. The small movements of the barrel are transferred to the short vertical arm of another bellcrank. This bellcrank is not pivoted but is suspended in a very striking manner, upon which the success of the instrument largely depends. A cross-piece at the elbow of the bellcrank is supported at each side of the machine by two steel strips at right angles to each other. One end of each strip is secured to the bellcrank, the other ends being secured to brackets cast on the base. The lever moves, therefore, without friction or backlash about the intersection of planes passing through the neutral axes of the strips. The arrangement is shown diagrammatically at *B*, Fig. 16. The short arm of the bellcrank carries a steel ball which contacts with the plane face of a small hardened disk let into a projection under the barrel, the point of contact being vertically over the intersection of the neutral planes of the strips supporting the bellcrank. In this way sliding friction is practically eliminated.

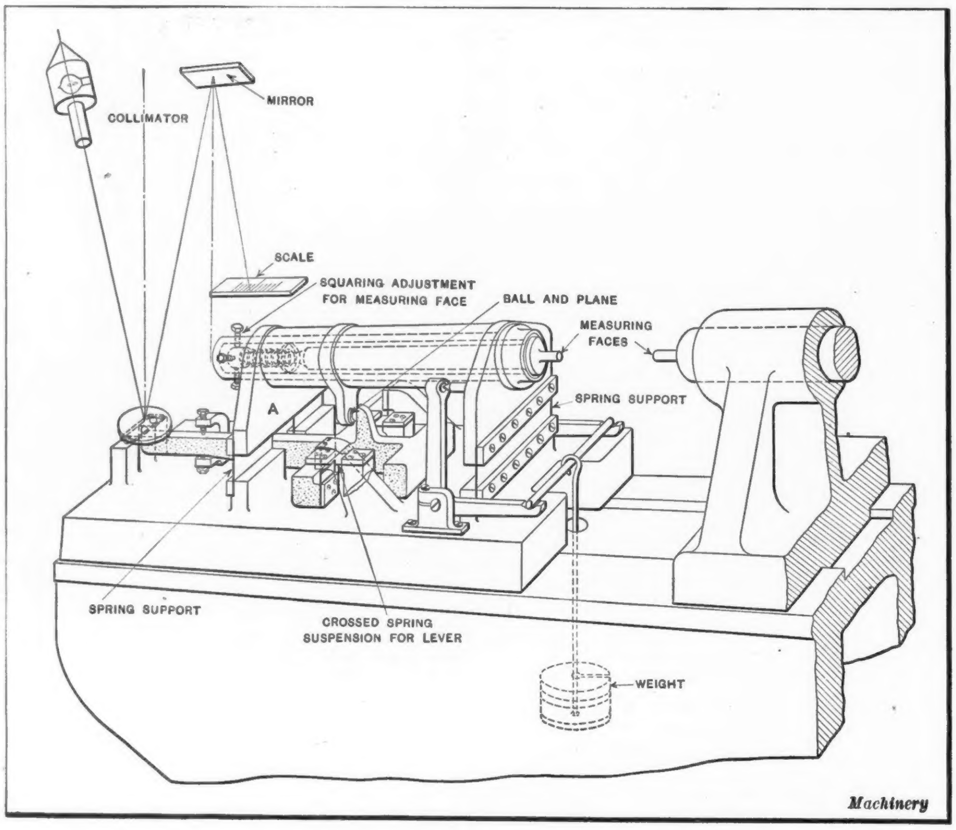


Fig. 15. Mountings of the Adjustable Measuring Anvil of Four-inch Comparator, and Optical Arrangement employed

It must be remembered that a movement of 0.000001 inch at the moving anvil is still of that magnitude at the ball contact. The long horizontal arm of the bellcrank multiplies the movement ten times. The movement here is transferred to a small circular disk carrying on its upper surface a plano-convex lens silvered on the under plane surface. The method of suspending the disk is clearly shown at *C*, Fig. 16.

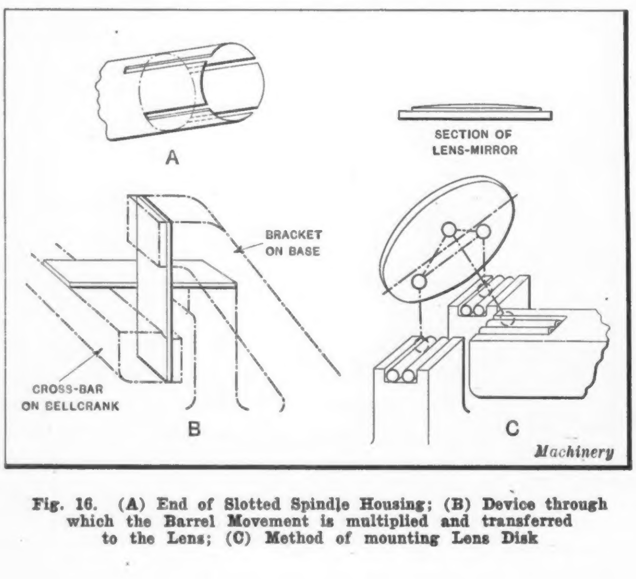


Fig. 16. (A) End of Slotted Spindle Housing; (B) Device through which the Barrel Movement is multiplied and transferred to the Lens; (C) Method of mounting Lens Disk

Three 1/16-inch balls are soldered on the under side of the disk, the middle ball being offset 0.1 inch from the center line of the two outer balls. The outer balls rest between two small cylinders 1/16 inch in diameter, which are laid in grooves cut in the two supports secured to the base. The other ball rests on a similar pair of cylinders located at right angles to the others and let into the upper face of the end of the bellcrank lever. Any movement of the bellcrank will, therefore, tilt the mirror lens with a minimum amount of friction. All the contacting surfaces are polished and the weight of the lens mirror and backing disk is reduced as much as possible.

In an almost vertical position above the lens, the focal length of which is about 80 inches, a 100-candlepower "Point-o-lite" lamp passes light through an attached condenser or collimator. A fine wire is stretched across the condenser field so that an image of the cross-wire, illuminated by the lamp, may be brought to a focus after reflection from an overhead mirror to a scale situated immediately behind the moving barrel. As the height from the lens mirror to the fixed overhead mirror is 5½ feet, and as the light traverses this distance twice, the long arm of the optical lever is 5½ feet multiplied by 2, or 132 inches. The short arm of the optical lever is the distance of offset of the three balls supporting the lens mirror; that is, 0.1 inch. As the beam reflected from the tilting lens mirror turns through twice the angular tilt of the mirror, we have to multiply the result by 2, and since the bellcrank mechanical advantage is 10, the total magnification is:

$$10 \times (132 \div 0.1) \times 2 = 26{,}400$$

A travel of 0.00001 inch of the moving anvil gives a deflection on the scale therefore of about ¼ inch. The scale is calibrated by means of standard gage-blocks varying in size by 0.0001 inch, the divisions obtained being subdivided into 0.00001 inch. Readings to one-tenth of these latter divisions, that is, to millionths of an inch, can be readily taken. Owing to the use of flat measuring faces, cleanliness of the gages and faces is even more important than with the machine previously described, but it is possible with this machine to measure pieces that have no plane faces.

In dealing with such minute differences, the question of the temperature at which estimations are made is extremely important, since a rise of 1 degree F. will increase a 1-inch precision gage-block to approximately 1.0000064 inches, that is, an amount more than six times the sensitiveness of the machines used. It is, therefore, imperative that all comparative measurements should be carried out as rapidly as possible so that the gages shall not acquire an increased temperature through prolonged proximity to the body of the operator. The measuring faces will never come fully in contact with the gage faces unless both are thoroughly cleansed with alcohol or gasoline immediately before use. Ordinarily the faces are separated by the thin film which apparently adheres to all exposed surfaces, and in the case of polished steel amounts to between 0.000001 and 0.000002 inch in thickness. It is this film that supports the measuring pressure and also accounts for the phenomenon of "wringing."

* * *

PRECISION STUD-DRIVER

In assembling automobile engines for high-grade cars, it is required to drive studs so that there will not be a deviation of over 0.010 inch in the amount which different studs project above the finished surface. Such a degree of accuracy is not required because of mechanical considerations, but because of the superior appearance of the job when the studs are all set within this close limit of tolerance. For use in driving studs so that the projection above the surface will come within the required limits, a special stud-driver has been developed in one of the automobile plants. This tool is shown in Fig. 1. It is of quite simple design, consisting of an opening into which the stud projects so that it may abut against a stop *A* placed inside the stud-driver. The distance from the end of this stop to the finished lower face *B* is exactly equal to the amount by which it is desired to have the stud project from the work.

In using a tool of this type, it is only necessary to screw the stud down until the lower surface of the driver engages the finished surface of the work in which the stud is driven, thus stopping further turning of the stud and assuring the attainment of the required accuracy. Inside the body of the tool there is a three-lobed cam *C*, each surface of which engages a roller *D*. These three rollers grip the work, and as the tool is turned by hand, the cams inside the body force the rollers inward, the grip being proportional to the resistance offered by the stud against turning with the rollers. Three holes are drilled in the body of the tool to receive compression springs *E*, which serve the purpose of forcing the rollers up the inclined tracks *C* of the cam, so that when the tool is dropped over a stud, rollers *D* will engage the stud before the turning of the tool causes the cam *C* to force the rollers inward to secure a driving grip. With a tool of this kind, studs may be rapidly driven into place and held

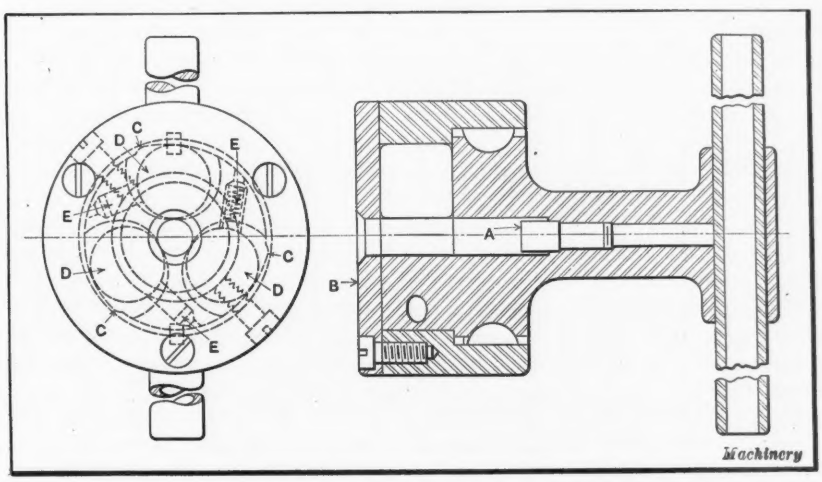


Fig. 1. Precision Stud-driver for driving Studs in Automobile Engines

Fig. 2. Use of a Stud-driver of the Type shown in Fig. 1

within the close limits previously mentioned. Time is saved that would otherwise be devoted to making repeated measurements to see that the studs are driven to exactly the required depth.

* * *

EDUCATION IN MANAGEMENT

A course in "management education" to provide a sufficient number of properly trained executives for the industries of the United States is to be established in many American colleges, according to an announcement made by Dr. Hollis Godfrey, president of the Drexel Institute, Philadelphia, Pa., formerly commissioner of the advisory commission of the Council of National Defense. The plan, an outgrowth of a convention attended by representatives of industry and colleges in Philadelphia last March, is backed by corporations representing a capitalization of $26,000,000,000.

The council of management education has been formed to become "a clearing house for all industrial and educational matters in the country, to promote the mutual understanding of the mutual problems of industry and the college, and to keep a perpetual inventory of the educational needs of industry and of the ability of the colleges to meet these needs." Temporary offices have been opened in the Drexel Building, Philadelphia, until headquarters are furnished in Washington.

An annual appropriation of $100,000, borne entirely by American industry, has been made to carry on this work, which has been divided into two classes: First, to determine the field of service which each college can cover, and second, to provide the college with all industrial data which may be utilized in forming courses for men contemplating entering industry, and in reaching the men already in industry through extension courses. Within one year, it is estimated, one hundred colleges will have included the extension industrial courses and all will be provided with the industrial material upon which to base undergraduate work.

On the executive committee which has this work in hand are members representing the railroads, public utilities, and the oil, textiles, mining, rubber, leather, paper, and machinery industries. The machinery industries are represented by Frederick H Payne, president of the Greenfield Tap & Die Corporation, Greenfield, Mass.

Small-quantity Production Methods

Application of Interchangeable Manufacturing Principles to the Methods Employed when Producing Machines in Limited Quantities

By EARLE BUCKINGHAM, Engineer, Pratt & Whitney Co., Hartford, Conn.

Interchangeable manufacturing methods, as considered in previous numbers of MACHINERY, relate to a comparatively high rate of continuous production for which the expense of a complete equipment of special tools, fixtures, and gages is justified, and for which the time and constant study required to keep the component drawings in proper shape is essential to prevent any break in the continuous flow of production. But, when any commodity is manufactured intermittently in small lots, the cost of such procedure is often greater than the results justify. Nevertheless, many of the principles involved in interchangeable manufacturing can be applied with economical results to the production of small quantities.

WHEN comparatively few machines of one type are manufactured, few parts are duplicated in great numbers, and so, similar surfaces, rather than similar parts, should receive attention. This requires a thorough analysis of the four following factors: (1) The possibilities of standardizing the nominal sizes so as to have the smallest possible number; (2) the possibilities of standardizing the minimum clearances between companion parts for each standard size to meet the various functional conditions; (3) the possibilities of standardizing the tolerances for the various standard sizes and conditions; and (4) the determination of the best surface to be maintained as a standard size; that is, whether it should be the maximum male surface or the minimum female surface. Until these factors are determined, it will be difficult to lay out a simple and consistent procedure that will result in economical production.

One caution must be given before further discussion is made of the subject of standardization. In order to obtain the best results, all known conditions involved must be given due weight; but the consideration given to any factor should depend on the frequency of its occurrence. One usual condition will far outweigh several exceptional conditions. An unusual condition will always require special consideration regardless of attempts at standardization. If an established standard will not meet the required condition, it should not be used. Regardless of the extent of standardization, exceptions will always occur and must be dealt with. Thus, a standard is theoretically the best construction that will satisfy the majority of the known conditions. In practice, however, all existing conditions must be met. Therefore, if an established standard is unsatisfactory for any particular service, unusual conditions are present and must be met.

Standardization of Nominal Sizes

It is evident that if the number of nominal sizes employed is reduced, the number of standard tools and gages required in the production department will be correspondingly reduced. As an example, the matter of reducing the number of nominal sizes of shafting was recently taken up by a committee of the American Society of Mechanical Engineers, and their recommendations are well worth following. Two distinct but closely related problems were considered. First, the standardization of the diameters of shafting used for the transmission of power, such as lineshafts and countershafts, etc. This usually consists of cold-rolled shafting which is used without machining. The following fourteen sizes have been adopted as standard for this type of shafting: 15/16, 1 3/16, 1 7/16, 1 11/16, 1 15/16, 2 3/16, 2 7/16, 2 15/16, 3 7/16, 3 15/16, 4 7/16, 4 15/16, 5 7/16 and 5 15/16 inches.

The second problem confronted by the committee was the standardization of the diameters of machined shafting used by machine-tool builders in making their product. For this purpose, the following have been adopted as standard: Sizes up to 2½ inches, increasing by intervals of sixteenth inches; from 2½ inches to 4 inches inclusive, by eighth inches; and from 4 to 6 inches by quarter inches. The foregoing sizes are sufficient to meet the majority of conditions. If proper attention is given to this point in the design of a mechanism, the use of unnecessary intermediate sizes will be eliminated.

Standardization of Minimum Clearances

The amount of the minimum clearance between companion parts depends on many factors. Among them are the size of parts, the length of the bearing, the class of fit required, and the conditions, such as temperature, etc., under which they must operate. The classes of fits which apply to cylindrical parts, for example, may be approximately summarized as follows: (1) Running fits, where one part must revolve freely; (2) sliding fits, where one part must slide freely; (3) push, or dowel fits, where neither part is required to revolve but where both parts must assemble readily, and be held in alignment; (4) force, driving, or shrinkage fits, which are made with pressure or by shrinkage, and used in assembling parts which must be held in fixed positions.

The amount of the minimum clearance for a running fit is dependent, to some degree, on the length of the bearing. A long bearing, for example, may have a somewhat greater clearance than a short one. The proper length of the bearing depends on the load and the material used in the bearing. The load controls, to a large extent, the diameter of the bearing. Thus, the first step toward standardizing the minimum clearances is to determine the most common material employed in making the bearings, and to establish standard lengths of bearings for the various diameters of shafts. The exceptions which will inevitably develop must, of course, be treated on their own merits. Take, for example, a long feed-screw or a long bending roll which is supported on the ends. Regardless of the diameter or length of the bearing, greater minimum clearances than the established standard would be required. If the number of similar exceptions is appreciable, supplementary standards can be developed to meet them.

Another factor which must be considered before the standards can be safely established, relates to the conditions under which the parts must operate. Thus, if the parts must operate when subjected to higher or lower temperatures than normal shop temperatures, due allowance must be made. On the other hand, if such temperatures are the exceptions, the corresponding clearances must be exceptions. A good example of this occurred with a concern that manufactures power presses, several of which were ordered by a plant in Alaska. The shed in which the presses were set up was unheated; for this reason the lubricating oil became very

heavy, and the presses would not work properly until the clearances in the bearings had been increased sufficiently to permit the heavier oil film.

In a similar manner, standards for all other classes of fits desired should be developed, not only for cylindrical but also for all other common surfaces. Every attempt should be made to standardize the more common surfaces and conditions first, and the others as it proves advisable.

Standardization of Tolerances

When manufacturing interchangeable parts in large quantities, the tolerances should be as great as the functioning of the mechanism permits, in order to secure the greatest economy of manufacture. As the functional conditions will vary so much, this practice seldom permits any great standardization of tolerances. On the other hand, when manufacturing in small quantities, using standard tools and equipment wherever possible, the tolerances should represent as far as possible, results which may be consistently obtained with the use of standard tools and which will insure that the parts will function properly. The first step, therefore, toward standardizing the tolerances is to determine the accuracy of parts produced by the various manufacturing methods. In this way, standard tolerances for each method will be developed, such as tolerances for grinding, reaming, drilling, boring, finish-turning, rough-turning, milling, planing, etc. The next step is to establish a practice for machining the various functional surfaces according to the requirements which they must meet. For example, on shafts, all running fits should be ground, all bearings should be reamed, etc. In general, the extent of the tolerances will increase as the sizes of the parts increase. Thus, for each method of manufacturing, a standard tolerance should be determined for each standard size.

Maximum Male or Minimum Female Size as Standard

In considering whether the maximum male or minimum female basic size should be the standard, shafts and their corresponding holes will be dealt with. In general, the tools for making the holes, such as drills, reamers, etc., are non-adjustable, while the tools for machining the shafts are adjustable, either in themselves or are carried on adjustable members of the manufacturing machines. This makes a strong argument in favor of maintaining the basic size of the holes as standard. This practice is now becoming quite universal. Of course, an exception to this will always occur when cold-rolled shafting is to be used without machining.

A little study will show that this practice can be applied to advantage on other surfaces. The basic dimension of the width of a slot or groove can be kept standard, and the necessary clearance can be provided by reducing the size of the mating member.

Effecting Economy by Using Standard Parts

The development and use of standard parts offers one of the greatest opportunities for economy in the manufacture

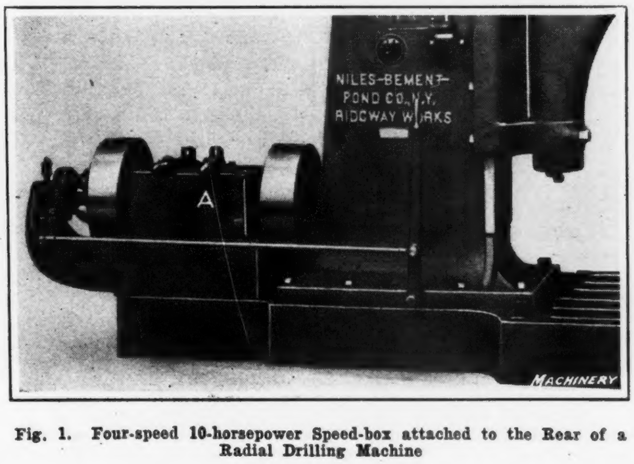


Fig. 1. Four-speed 10-horsepower Speed-box attached to the Rear of a Radial Drilling Machine

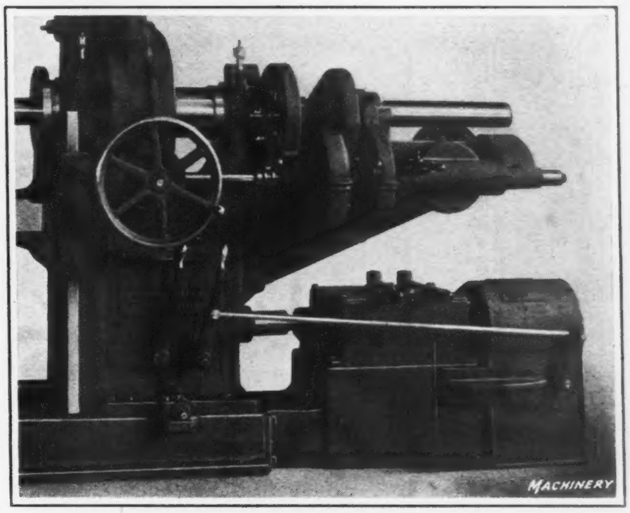


Fig. 2. Speed-box applied to a Horizontal Boring Machine

of small lots of commodities. The greatest difficulty in the way of accomplishing this is the necessity of training the designers to use them. There seems to be a fear among these men that the extensive use of such standard parts will limit their initiative and curtail their originality. The fact is the extensive use of standard parts will eliminate a large amount of the designer's drudgery, thus freeing much of his time and thought for creative work.

In order to promote the use of standard parts, records relating to them should be made in a simple and convenient manner. Certain types of parts, such as levers, gears, bushings, studs, pulleys, etc., should always be considered as potential standard parts, even if certain of them are used merely in a single place, and should be tabulated or indexed for ready reference. In this way a series of standard parts is readily begun. After the start, a study should be made and a balanced series laid out to cover possible future needs. Otherwise the series will be unbalanced, that is, the differences between some of them will be very small, while between others they will be very great. Such a series would eventually contain an excessive number in order to cover a given range. The essence of standardization is to reduce the number of standards to a minimum.

Standardizing Unit Assemblies to Suit Several Machines

The design of the commodity which is to be manufactured in small lots should be carefully studied and every opportunity taken to incorporate smaller unit assemblies. As with many of the component parts, each unit assembly should be considered as a potential standard. If this is done, many of them, such as oil-pumps, speed- and feed-boxes, reversing mechanisms, etc., will be found applicable to several machines.

An interesting example of what is possible along these lines is shown in the accompanying illustrations. Here a standard four-speed, 10-horsepower speed-box is illustrated on various types of machine tools. In Fig. 1, this speed-box is shown at *A* attached to the rear of a radial drilling machine. In Figs. 2 and 3, it is attached to different types of horizontal boring machines, its position again being indicated by *A*. This speed-box is also illustrated in Fig. 4, at *A*, as part of a large slotter. The various machines themselves are made in small lots as required, but these speed-boxes, and other common standard parts, are made in relatively large lots and carried in stock. This example indicates to a small degree the many possibilities along these lines.

It is of interest to note in this connection, that one large corporation which controls several plants building many different kinds of machine tools, has been carrying out a standardization program for several years. Certain types of parts and some unit assemblies which have been developed at the different plants have been compared and discussed.

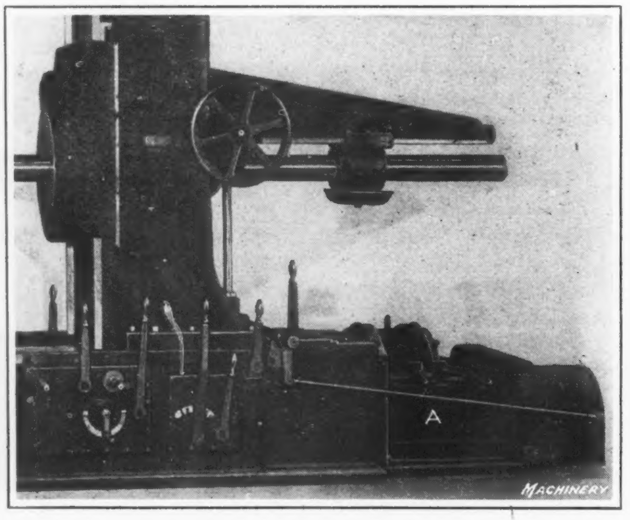


Fig. 3. Application of Speed-box to Another Horizontal Boring Machine

In most cases, this discussion has led to the adoption of a certain series of them as standards for all plants. In addition, the plant best fitted for that particular work has been selected to manufacture all of such parts or unit assemblies for all the plants. In this way, the economies resulting from producing in large quantities are secured, where no one of the plants involved has a very large production of any one size and type of machine tool. As with standard parts, if any extensive use is to be made of standard unit assemblies, they must be recorded and tabulated in a simple and convenient form for ready reference.

Component Drawings for Small-quantity Production

The component drawings of a mechanism which is to be manufactured in small lots will vary considerably from those used when the production is large. As a rule relatively few of the operating clearances and also few of the manufacturing tolerances will be specified. Notes, such as "force fit," "running fit," etc., will be the usual method of noting this information.

To determine properly the correct clearances and tolerances for any surface, much time is required for studying the design, checking results obtained on the various surfaces in production, etc. When parts are made in small quantities, there is little or no opportunity to do this work, although to specify these requirements without such study is generally useless. At best they are only a guess, and are often established by some one who knows little of the actual working conditions.

When a part becomes standard, or when elementary surfaces as in holes and on shafts are standardized, the production of these parts and surfaces is large enough to permit the necessary study and tests to be made. Here the component drawings should specify the maximum and minimum sizes exactly as in the case of component drawings for large-quantity production. A full discussion of the requirements of such drawings is given in the articles published in the November and December, 1919, and in the January and February 1920, numbers of MACHINERY.

Manufacturing Equipment

Relatively little special manufacturing equipment is provided for manufacturing in small lots. Generally nothing more than boring jigs and planer templets is necessary. The machine operators are usually skilled machinists and perform most of the machining cuts on standard machine tools with the use of standard cutting tools. Each piece of work is set up and clamped to the bed of the machine with only the aid of standard measuring tools to test its position. With such a type of operator, the component drawings do not actually require the same amount of detailed information as is necessary when the work is performed by less highly skilled labor.

In many cases, not even boring jigs or planer templets are provided; the work is first laid out, and then the machining cuts are taken to match the lines drawn. As the production increases, however, more and more special manufacturing equipment can be used to advantage. As the quantities become large enough to pay for the cost of this equipment, its provision and use will greatly promote economical production. The essential requirements of this equipment, whether much or little is provided, are identical with the requirements of equipment for manufacturing large quantities.

Gages and Methods of Inspection

The gages used in this type of manufacturing consist principally of standard measuring instruments and plug, ring, and snap gages of standard sizes. Thread gages for standard threads are also used to an appreciable extent, as well as adjustable snap and plug gages which may be set with the aid of standard measuring instruments or standard size-blocks. Where adjustable gages are used, it is very desirable to have means for sealing them so that they may be adjusted in the tool-room but not promiscuously in the shop.

When boring jigs are provided, these form in themselves effective gages for testing the location of holes by using suitable plug gages and bushings in place of the boring tools. When planer templets are employed, these also make effective gages, an indicator being substituted for the planer tool. As with other manufacturing equipment, gages should not be provided until the volume of production is great enough to make their use economical.

The inspection of parts made in small quantities, where stock is left on many pieces for fitting at assembly, and where the component drawings give incomplete information, is quite different from the inspection of parts made in large quantities. The extent of the inspection required depends to a large extent on the methods of paying the workmen. For example, when the wage is paid on a time basis alone, this inspection is relatively slight. On the other hand, if piece-work prices or bonuses are paid, a more complete inspection is required, as a bonus should not be given for spoiled work.

Most of this inspection requires a skilled workman, as little special gaging equipment is available, and this necessitates the use of standard measuring instruments in many cases and also many special set-ups. In addition, with the incomplete component drawings, the inspector must be sufficiently experienced to tell whether or not the parts as completed will function properly when no fitting is to be done at assembly. When fitting is required, he must also be able

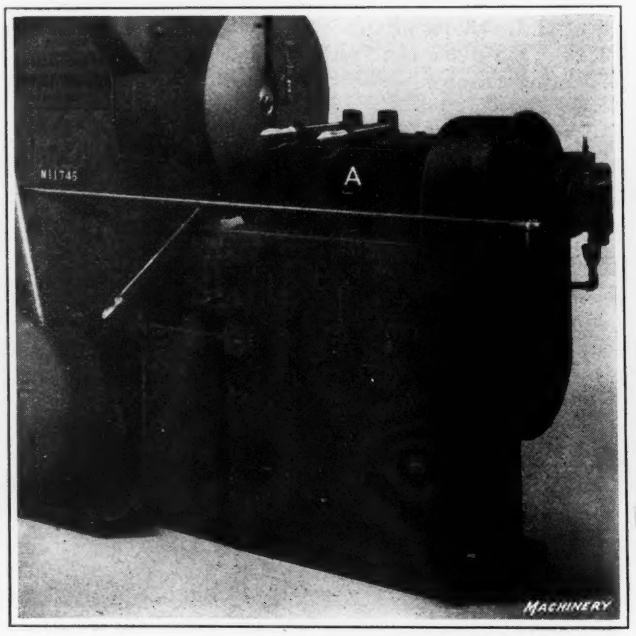


Fig. 4. Slotter equipped with Same Speed-box as shown on Other Machines

to determine whether or not the amount of stock left for this purpose is suitable.

On large pieces, the inspection should be made while the part is set up on the machine used in finishing it, so that if corrections are necessary, they can be made without an additional set-up. When no special locating fixtures are employed and a part is removed from the machine, it is almost impossible to relocate it in order to correct one surface and yet keep the proper alignment with the other finished surfaces. The inspector should be capable, not only of detecting errors, but also of convincing the workman of them without antagonizing him. The inspection of standard parts should be carried on in the same general manner as the inspection of parts produced on a large-quantity basis.

The assembling of small lots of machines usually involves a considerable amount of fitting. For example, all the small holes are not drilled in the larger pieces until assembly. Small brackets and similar parts are then clamped in position and the holes for their holding screws, dowels, etc., are located from them. Sliding members are scraped to fit each other, and to correct their alignment. This requires a certain amount of machinery on the assembling or erecting floor and also the services of skilled mechanics. However, as much of the machining as possible should be completed before the parts reach the assembling department. In most cases, this requires the provision of special manufacturing equipment and gages. Thus as the quantity of the production increases and more and more special equipment is furnished, less fitting at assembly is necessary. After the machines are assembled, they should be carefully tested for alignment, backlash, etc., and when possible, they should be actually tried out on work of the character they are made to perform. This last is the crucial test because upon its results the success or failure of the mechanism is judged.

* * *

ROTARY FIXTURE FOR MILLING BUSHINGS

In the plant of the De Laval Separator Co., Poughkeepsie, N. Y., an old-style Brown & Sharpe rim milling machine is used for straddle-milling cast-iron bushings to length, and the excellent results obtained by equipping this machine with the fixture shown in Fig. 2, clearly indicate that a machine of this kind is especially adaptable for single-purpose operations on work of this general character. This is one of the various production jobs on which it can be safely said that no material advantage would be gained by employing modern machine tools of more or less complicated design.

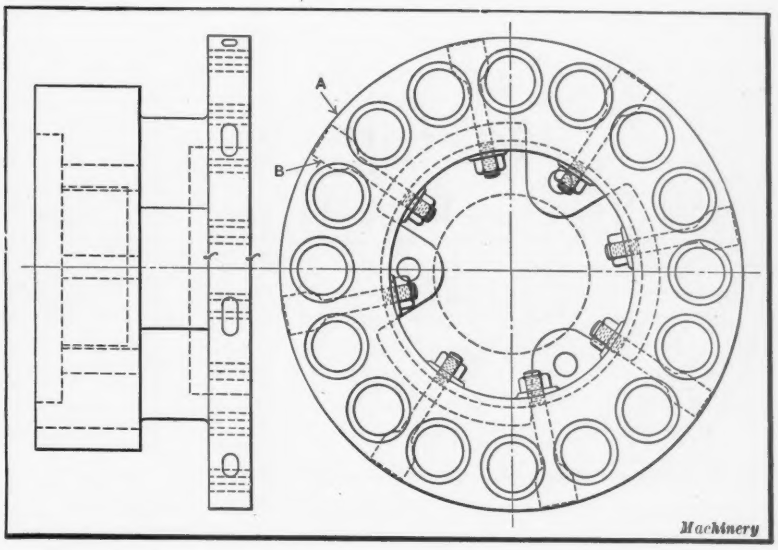


Fig. 2. Detail View of the Rotary Fixture used to carry Sixteen Bushings when machining them to Length

The fixture with which the machine is fitted is shown in detail in Fig. 2, and mounted on the work-spindle in Fig. 1. The body of the fixture *A* is made of cast iron and carries sixteen hardened tool-steel bushings. It will be seen that each pair of these steel bushings is held in place by means of machine-steel lock-bolts *B* so that they may be readily replaced when so desired. The bushings which are machined in this fixture are made of soft gray iron, the rough castings being 2¾ inches long. These castings are first turned and cut in two on a Cleveland automatic, thus producing two bushings, each 1 5/16 inches in length. These are then ground to a diameter of 1 inch before being machined on the end by the machine shown in Fig. 1. The bushings are a push fit in the steel bushings of the fixture, from which they project on each side enough to permit an average of 7/64 inch to be removed by each cutter; that is, the finished length of the bushings is 1 3/32 inches. The diameter of the fixture on the center line of the bushings is 10 inches, and the fixture revolves at the rate of one revolution in 10.35 minutes so that the work is fed to the cutters at the rate of about 3 inches per minute. With due allowances for the time that is consumed in setting up and replacing the cutters, a production rate of approximately 85 bushings per hour is attained.

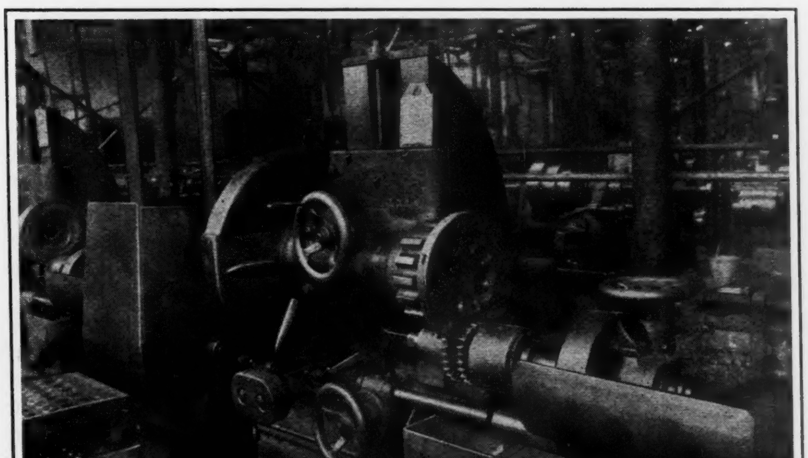
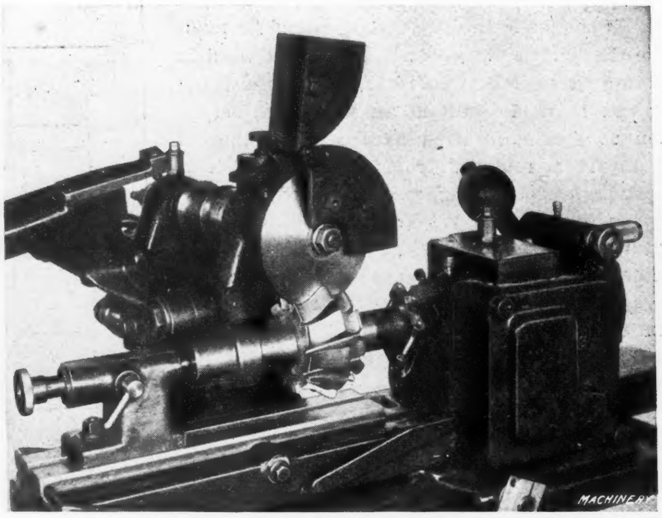


Fig. 1. Milling Machine equipped with Rotary Fixture for straddle-milling the Ends of Cast-iron Bushings

It will be realized that this is a continuous milling operation. The fixture is loaded and unloaded while in motion, and there is no necessity for stopping the machine; consequently, no time is lost by the operator after the machine is once in operating condition. Two side milling cutters, ¾ by 5 inches in diameter, are used, the speed of the cutter-arbor being 85 revolutions per minute. A tray of bushings is shown resting on a table near the machine, in which the bushings are placed in lots of 100. It may be well to state that the cast-iron blanks from which these bushings are made are also used to produce a bushing of the same diameter but of 2 15/32 inches finished length. The same type of equipment is employed in straddle-milling these long bushings as has just been described, but in this case the depth of cut is 9/64 inch instead of 7/64 inch. The same production rate of 85 pieces per hour is maintained and the same speeds for both cutter-spindle and work-arbor are employed.

Making "Curvex" Milling Cutters

Methods and Equipment Employed by the Pratt & Whitney Co., Hartford, Conn., in the Manufacture of Formed Milling Cutters with Helical Flutes



THERE are parts of many metal products which can be efficiently machined through the use of formed milling cutters, but two reasons have influenced shop men against the use of tools of this type. Of these, the first was that difficulty was experienced in making tools of this type, and the second, that practical limitations made it impossible to produce formed cutters with helical flutes. Realizing the important advantages which are secured through making all types of milling cutters with flutes of helical form, the Pratt & Whitney Co. of Hartford, Conn., conducted an exhaustive study of the conditions which must be fulfilled in order to manufacture formed milling cutters with helical flutes, with the result that methods and special machinery have recently been perfected for the production of what are known as "curvex" milling cutters.

How Straight-fluted Formed Cutters are Made

Before entering upon a discussion of the methods used by the Pratt & Whitney Co. for making these spiral-fluted formed milling cutters, it will be well to consider briefly the methods used in the production of straight-fluted formed cutters. Regardless of whether the flutes are straight or helical, the turning and boring of the blank and the milling of the flutes are quite simple machine shop operations. The outstanding difference in practice occurs in relieving the teeth. With a straight-fluted cutter, the method of procedure in backing off or relieving the teeth is to take a formed tool or "knife" as it is called by toolmakers, the contour of which conforms with the tooth outline of the milling cutter.

This backing-off tool is used to take a cut over the entire width of each tooth, and it will be evident that working under such conditions—especially with wide-faced cutters—the operation must be handled with extreme care and deliberation, in order to prevent setting up excessive strains in either the machine, the work, or the relieving tool. With helical-fluted cutters, this method of relieving cannot be employed; and it is the difficulty experienced in relieving the teeth of such formed milling cutters that has constituted the stumbling block which has prevented tools of this kind from coming into general use, after the advantageous features of other helical-fluted cutters had come to be thoroughly understood.

How Helical Flutes Improve the Cutting Efficiency

It is a matter of quite general mechanical knowledge, that by having the flutes of a milling cutter of helical form, the cutter is able to work with less vibration, and a better finish may be produced on the work because of the shearing action that is secured. The ability of the helical flutes to reduce vibration will be readily appreciated when a comparison of their action is made with that of a straight-fluted cutter which has the entire cutting edge of each successive tooth engage the work at the same instant. On the other hand, the action of the helical flute is progressive, the cutting edge coming into contact with the work at one side of the cutter, and this point of contact then moving across the cutter as the tool rotates, until finally the point of contact is lost at the opposite edge of the tool.

One good way of explaining this difference of action is to regard the helical-fluted cutter as a composite tool built up from a large number of straight-fluted milling cutters of infinitely narrow face width. Such a set of cutters could be mounted on an arbor, the cutting edge of each tool slightly behind the edge of the adjacent tool. If such a built-up tool were rotated in contact with the piece of work, it will be apparent that the edges of each of these narrow cutters would come into contact successively, thus accomplishing their

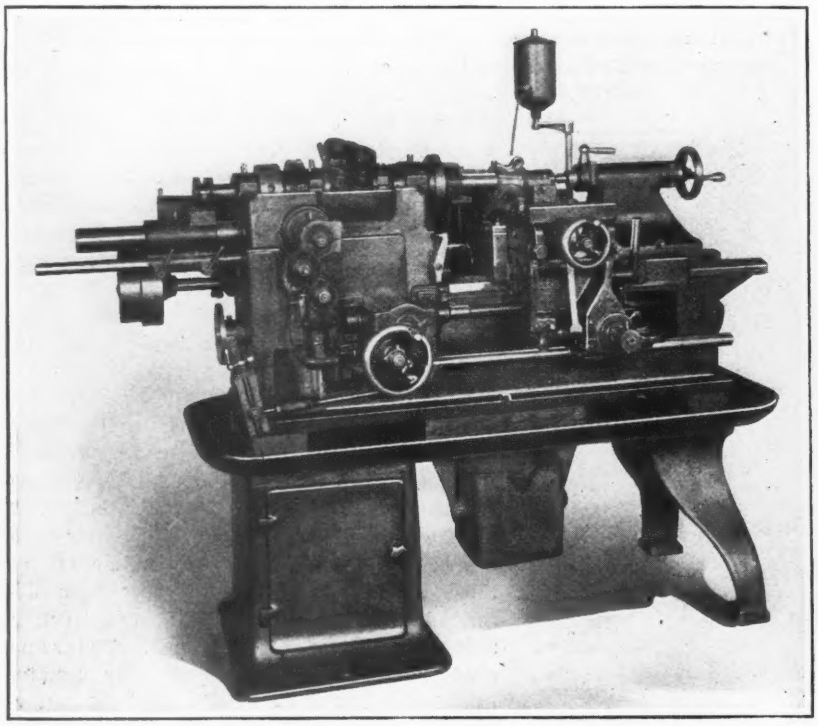


Fig. 1. Automatic Machine for Use in backing off Teeth of "Curvex" Milling Cutters

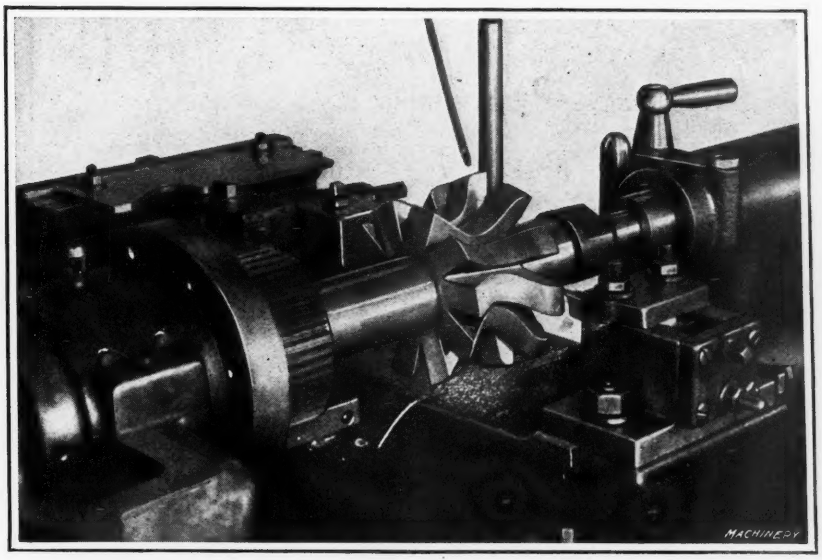


Fig. 2. Close-up View of Cutter, Relieving Tool, Templet, and Tracer Point

cut without producing the vibratory effect that would be induced through bringing all of the cutters simultaneously into contact with the metal to be milled.

Relieving Pratt & Whitney "Curvex" Milling Cutters

Mention has already been made of the fact that so far as turning the cutter blank and milling the flutes are concerned, there is nothing unusual in the procedure followed in making "curvex" milling cutters. In the past it has been impossible to make cutters of this type because of the difficulty encountered in relieving the teeth, and of developing machines and methods of doing this work. The solution was found by Frederick Müller, acting in a consulting engineering capacity for the Pratt & Whitney Co. Mr. Müller for many years has been known in the machinery trade as "Automatic" Müller as a result of his work in designing automatic machinery of many different types. Mr. Müller developed automatic machines for handling this work, so that one operator is able to give the necessary amount of attention to a large number of machines. As shown in the close-up view, Fig. 2, it will be seen that there is a relieving tool which operates on the milling cutter teeth, and a tracer point that engages the edge of a templet which is employed to control the form of the cutter. Naturally, the templet is made of exactly the same form as the work that it is required to mill; and in order to obtain accurate results, it is important to have the tracer point and the relieving tool the same shape and size.

Fundamentally, the backing off of helical-fluted formed milling cutter teeth is accomplished in exactly the same way as the relieving of the teeth of any other rotary tool, it being merely required to produce the necessary clearance behind the cutting edge of each tooth. But very little thought will be sufficient to convince the reader that the backing off of the teeth of formed cutters with helical flutes is by no means a simple problem. Evidently it is necessary to provide for so guiding the backing-off tool over the work that the required contour of the cutter will be maintained, and also to so adjust the angular position of the cutter as the backing-off tool is fed longitudinally across its face, that the required compensation will be made for the lead of the helix. In addition, the usual oscillating cross-slide for manipulating the backing-off tool, and means of feeding the tool longitudinally across the face of the cutter must be provided.

Machines used for this purpose are equipped with two independent sets of mechanism that operate alternately to produce the following results: One set of mechanism provides for rotating the spindle by which the cutter blank is driven and for imparting the necessary oscillatory movement to the cutter-slide. The other is depended upon to traverse the carriage along the bed of the machine to impart the necessary feed movement to the relieving tool, and while this feed movement takes place to rotate the cutter blank through a sufficient part of a revolution to compensate for the helical flute form and maintain a constant relationship between the relieving tool and the flutes of the milling cutter blank. The two sections of the machine work intermittently, so that while the spindle is revolving the cutter and the relieving tool-slide is oscillating, there is neither a feed movement nor a rotary compensating movement of the cutter; and conversely, while the feeding of the relieving tool and the adjusting of the cutter are taking place, the machine spindle and relieving slide are at rest.

Arrangement of the Mechanism in the Machine

It will be apparent from Figs. 4, 5, 6, 8, and 9 that driving of the machine is accomplished by means of a pulley *A* from which motion is transmitted through a positive clutch *B* to either of the two sections of the machine which were just mentioned. Clutch *B* is of the so-called "load and fire" type, and energy is stored up in the operating spring by means of a lever *C*, Fig. 8, the movement of which is accomplished by means of a cam carried by the main camshaft located inside the bed of the machine. For transmitting power to the spindle and for oscillating the cross-slide on which the relieving tool is mounted, the drive is carried from clutch *B*, Figs. 4 and 5, through a speed-change box *D* in which there is a cone of gears arranged to provide five speed changes. From this speed-box, power is transmitted through bevel gears *E* to a worm and worm-wheel *F*, Fig. 8, that is connected to the spindle and rotates with it. The cross-shaft that carries the spindle-driving worm is carried through to the front of the machine to transmit motion through a set of change-gears *G*, Fig. 6, that provides for timing the rota-

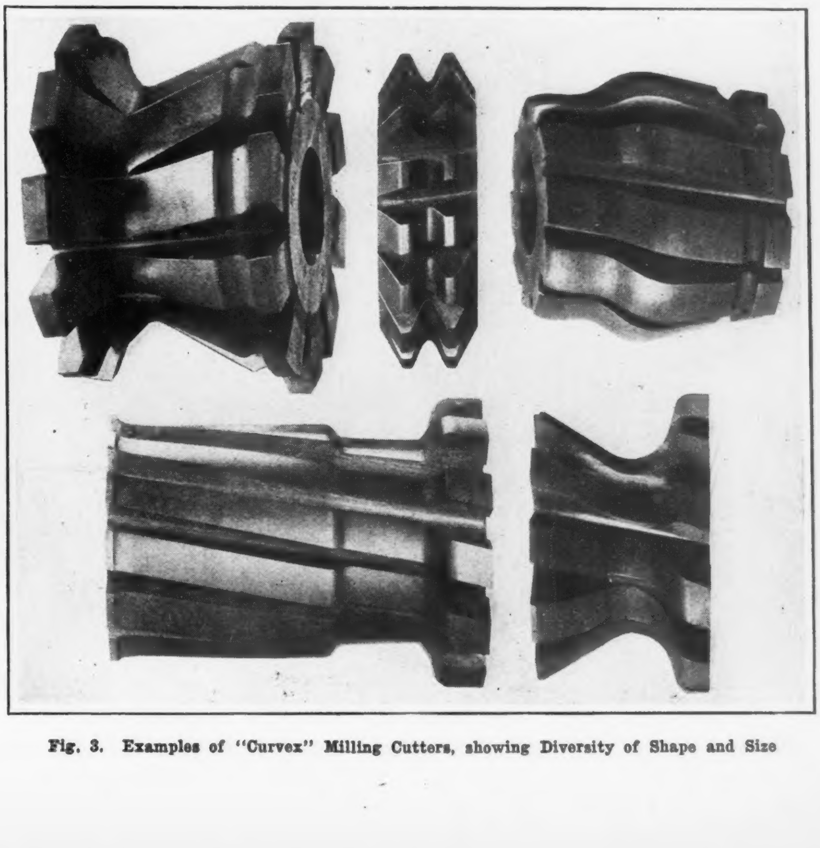


Fig. 3. Examples of "Curvex" Milling Cutters, showing Diversity of Shape and Size

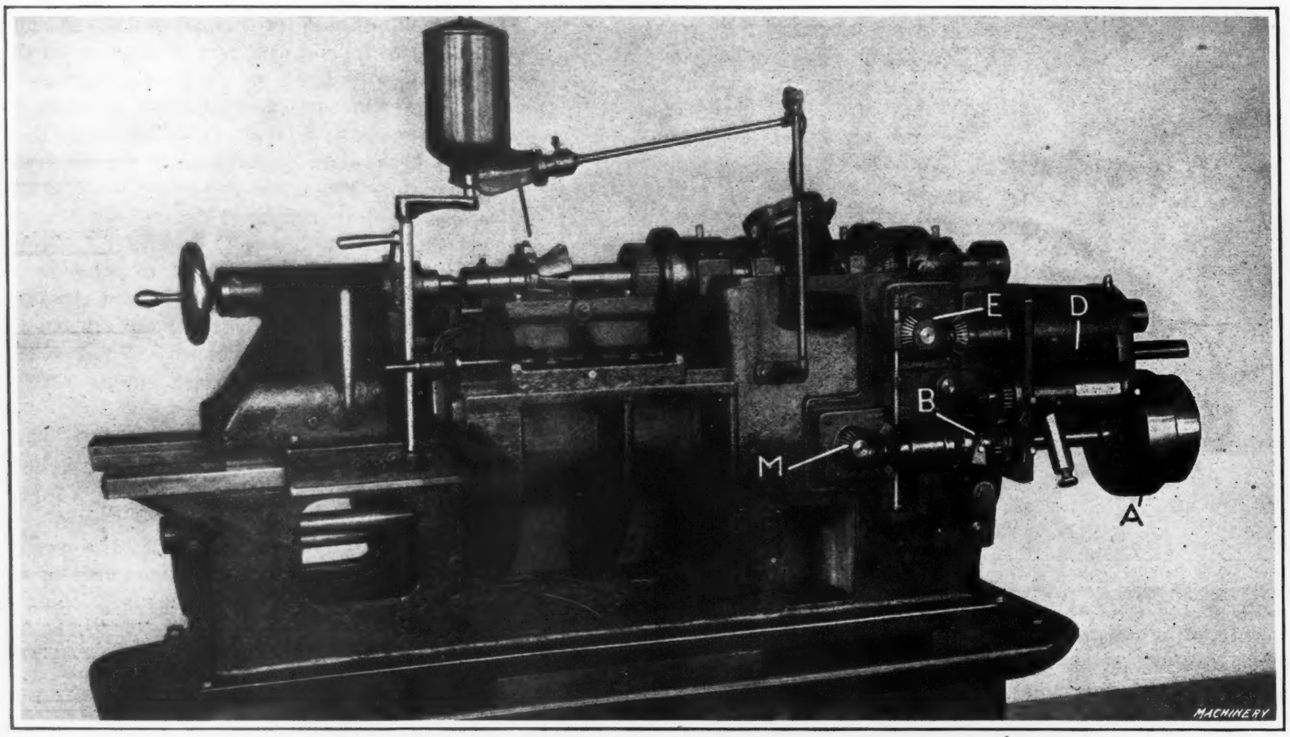


Fig. 4. Rear View of Automatic Machine for relieving "Curvex" Cutters, showing Arrangement of Drive

tion of the machine spindle with the oscillation of the relieving slide, so that the reciprocating movement of the tool will be properly synchronized for the number of flutes in the milling cutter that is being relieved.

From the change-gears *G*, motion is transmitted through bevel gears *H* and a horizontal shaft to a worm and wheel *I*, and a second pair of bevel gears to a shaft on which cam *J* is carried. This cam runs in contact with a roller mounted at the lower end of lever *K*, the upper end of this lever being connected with the cross-slide on which the relieving tool is carried. In this manner a reciprocating movement is imparted to the slide. While the main driving clutch *B* is engaged to transmit motion to this part of the mechanism, the spindle makes one revolution and the relieving slide is moved in a number of times equal to the number of flutes in the cutter, thus taking a relieving cut over each tooth.

Mechanism for Feeding Carriage Longitudinally

Before the work of relieving the cutter teeth can proceed further, it is necessary to move the tool along the face of the cutter, and this feed movement also makes it necessary to rotate the cutter slightly in order to compensate for the helical form of the flutes. With the main driving clutch *B* in the opposite position to that which it previously occupied, power is transmitted through bevel gears *M*, Figs. 4 and 5, to a shaft that transmits motion through a worm and wheel

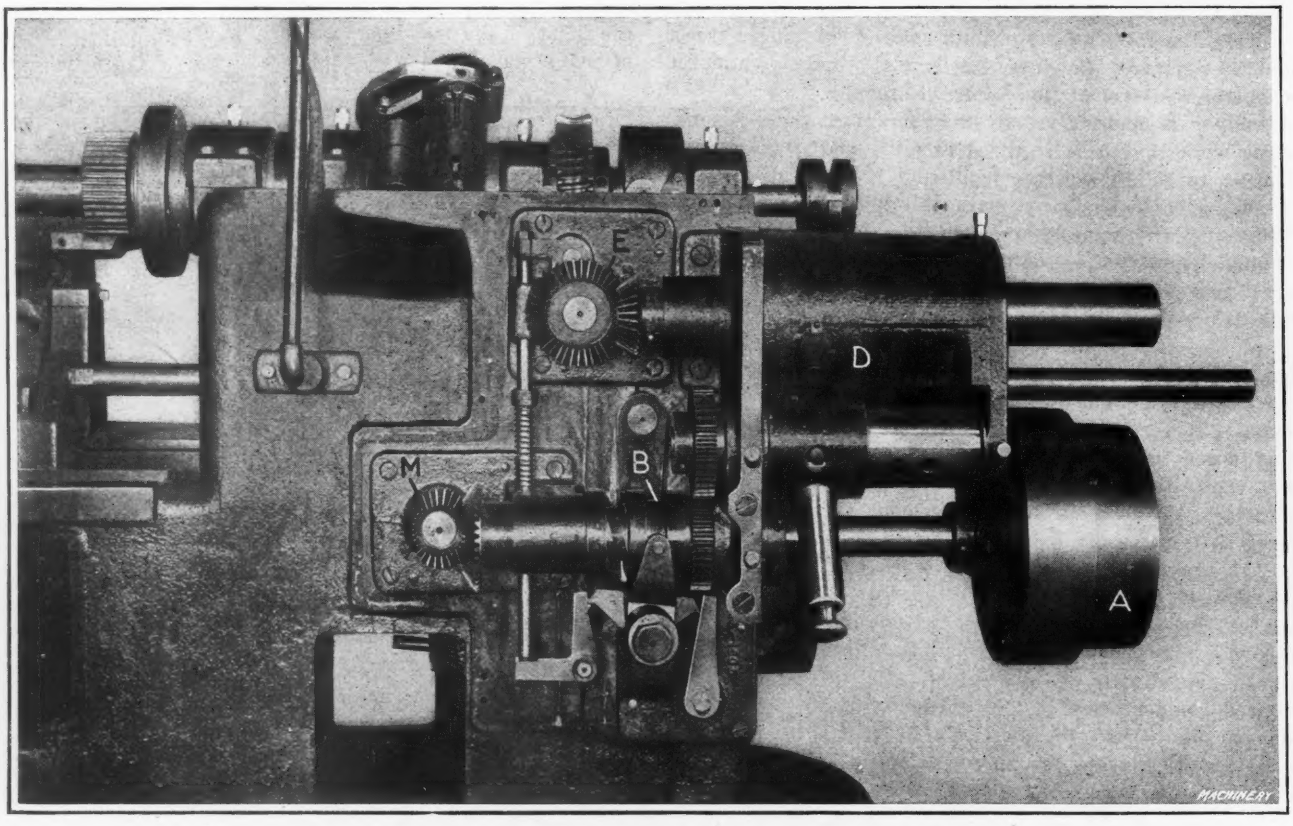


Fig. 5. Close-up View of Driving Mechanism on Automatic Relieving Machine

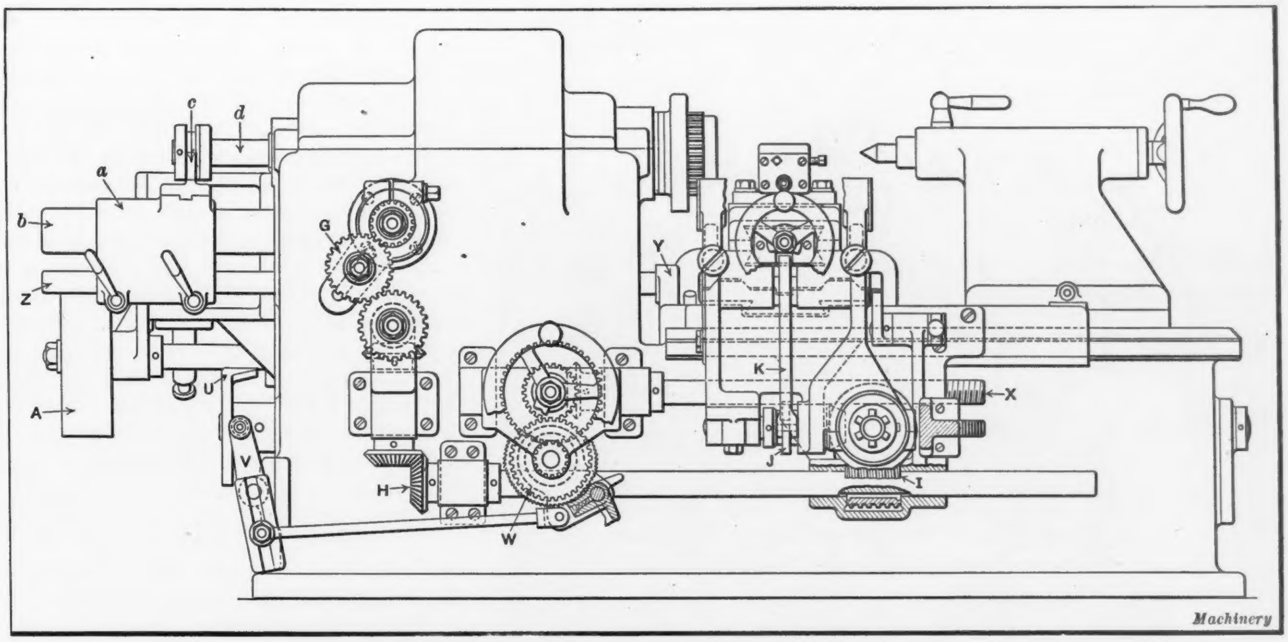


Fig. 6. Mechanism for transmitting Power to Oscillating Relieving Slide, feeding Relieving Tool, and adjusting Position of Milling Cutter

to a camshaft *N*, Fig. 8, mounted inside the bed of the machine. In order to explain the functioning of this part of the mechanism, let us assume that the relieving tool has just completed its work of taking a cut over each of the milling cutter teeth, and that it is required to adjust the machine ready for its next cycle of operations. At this point, attention must be called to the fact that the oscillating slide that carries the relieving tool is of a composite construction, as shown in Figs. 12 and 13, being composed of three slides mounted one on top of the other. The two lower slides may be clamped together to form a single member, or these slides may be released and moved independently of each other. The upper slide, while not clamped to the second slide, is carried by it, and is moved therewith by means of the relieving mechanism.

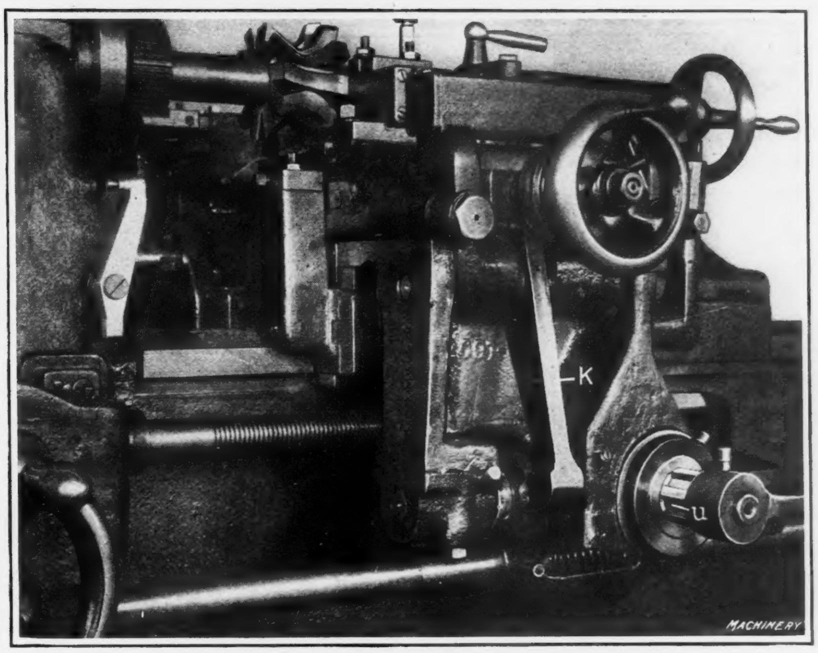


Fig. 7. Close-up View of the Cross-slide Mechanism

When the relieving tool has completed a cycle of operations, the rotation of the milling cutter stops with the tool opposite a groove between two teeth. Then

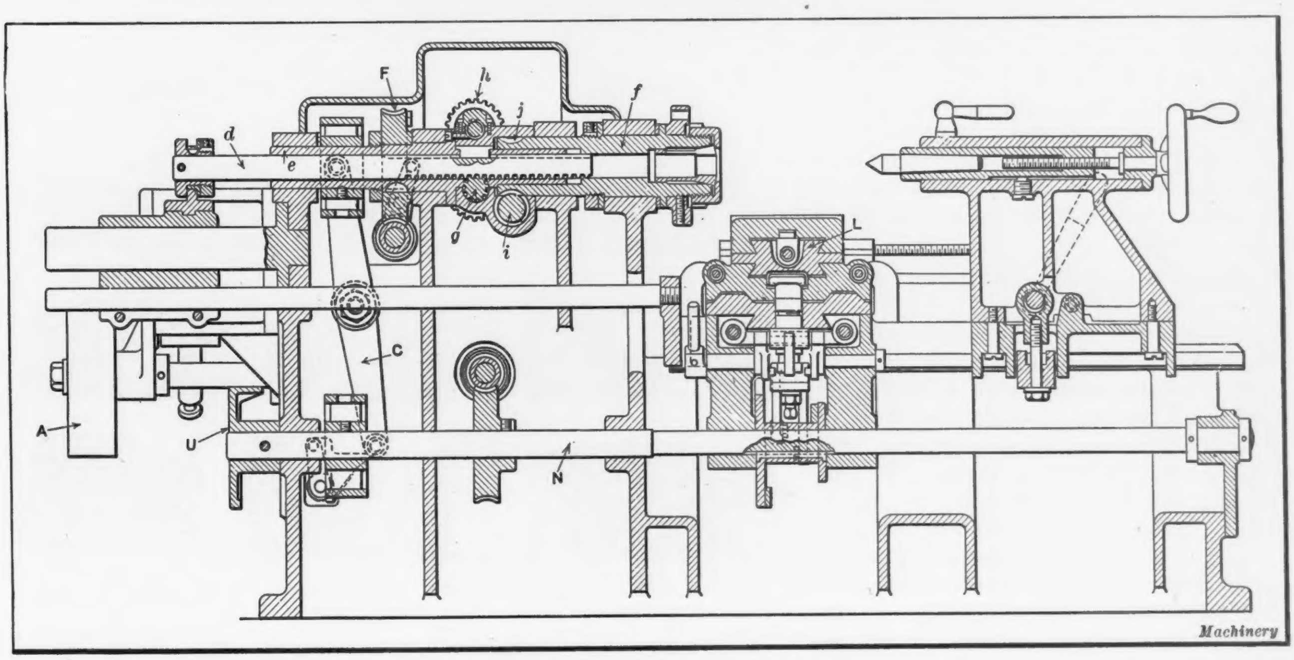


Fig. 8. Longitudinal Sectional View of Machine

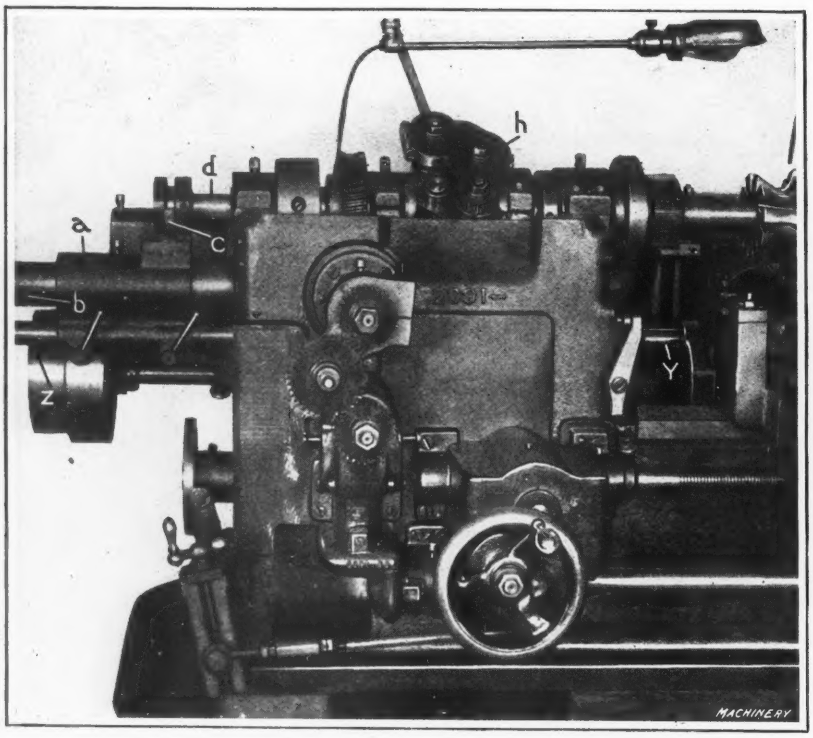


Fig. 9. Close-up View of Mechanism for transmitting Drive to Relieving Slide and for obtaining Angular Adjustment of the Milling Cutter

the cam O carried on shaft N oscillates lever P about its pivotal support, with the result that all three slides Q_1, Q_2, and Q_3, are moved backward together against the tension of springs R, about 1/16 inch. The purpose of withdrawing the slides in this manner is to enable the carriage to be fed longitudinally along the bed of the machine without interference between the former pin S and the templet T that governs the form of the milling cutter that is being relieved. Feed movement of the carriage is accomplished by a cam U, Figs. 6 and 8, mounted at the extreme left-hand end of camshaft N. This cam imparts an oscillatory movement to lever V which, through a connecting link, operates a ratchet and pawl that impart a specified movement to change-gears W. The position of the pin in crank V may be adjusted to regulate the amount of feed movement, crank V being graduated so that the position of the pin may be set opposite the mark indicating the required feed movement of the tool along the work in thousandths of an inch. From change-gears W motion is transmitted to a feed-screw X that controls the movement of the carriage.

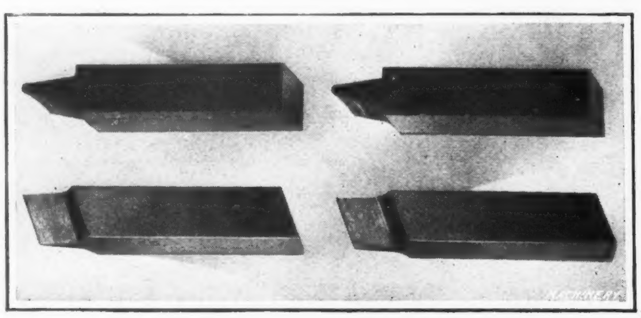


Fig. 10. Close-up View of Two Relieving Tools for relieving "Curvex" Cutters

Automatic Compensation for Helical Form of Flutes

At the same time that the relieving tool is being fed along the milling cutter, it is required to rotate the cutter to make the required compensation for the helical form of the flutes. This result is accomplished by a bracket Y, Figs. 6 and 9, on the carriage that imparts a longitudinal movement to rod Z, which is slidably held in bushings. Carried by this rod, there is a bracket a that slides on a guiding pilot b and has a yoke c attached to its upper side to provide for imparting a longitudinal movement to rod d. At its right-hand end, rod d has rack teeth cut in it. Before proceeding further with the description of this mechanism, mention must be made of the fact that the spindle that carries the milling cutter blank is arranged in two sections, namely, an inner spindle e, Fig. 8, on which the driving worm-wheel F is carried and an outer spindle or sleeve f surrounding the inner spindle and arranged with a socket at its forward end to receive the work-holding arbor. It will be apparent that a longitudinal movement of rod d results in imparting a rotary motion to pinion g and an arrangement of change-gears h carried on the spindle e and bodily rotatable therewith. By means of the gears h motion is imparted to a worm i and worm-wheel teeth cut in the outer spindle f at j. In this way, the cutter is rotated through a distance corresponding to the required angular adjustment for the longitudinal feeding of the relieving tool along the face of the cutter. The gears h can be changed to conform to various leads of helical flutes on the cutter.

At this step in the cycle, it is necessary to unlock the mechanism that clamps slides Q_1, and Q_2, Fig 12, together so that slide Q_2 may be moved independently of slide Q_1, in order to bring the former pin S back into contact with the templet T. Obviously the purpose of this setting is to bring the relieving tool into the required position to take a cut over each tooth while the milling cutter makes its next complete revolution. Movement of slide Q_2 is accomplished by means of spring k, Fig. 13, which is contained in a cylinder filled with oil. The construction of this part of the mechanism has been worked out on the dashpot principle, so that while spring k is able to return slide Q_2 to the required position, the oil will retard the movement so that there is no danger of causing vibration or of indenting either the former pin S or the master templet T. In fact, so delicate is the adjustment that it has been found possible to make a templet out of an ordinary playing card and use it

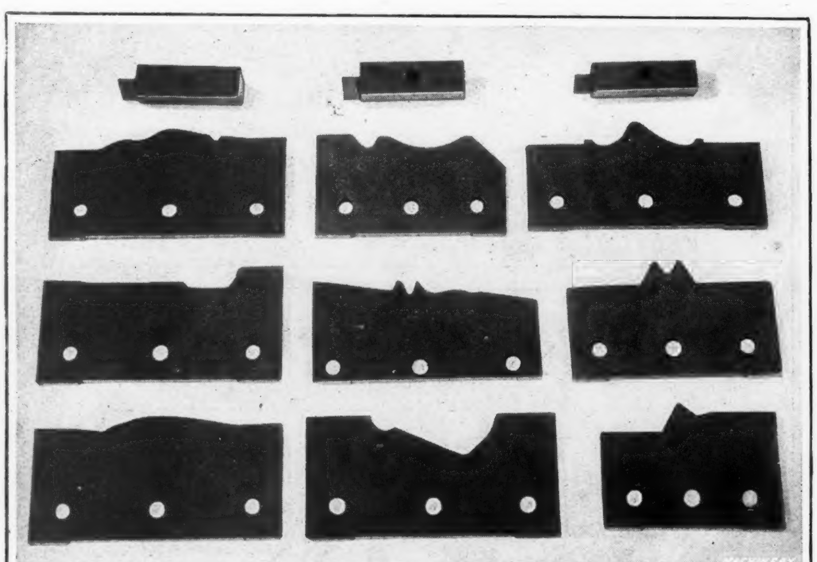


Fig. 11. Templets for governing the Form of "Curvex" Cutters, and Tracer Points used in Connection with these Templets

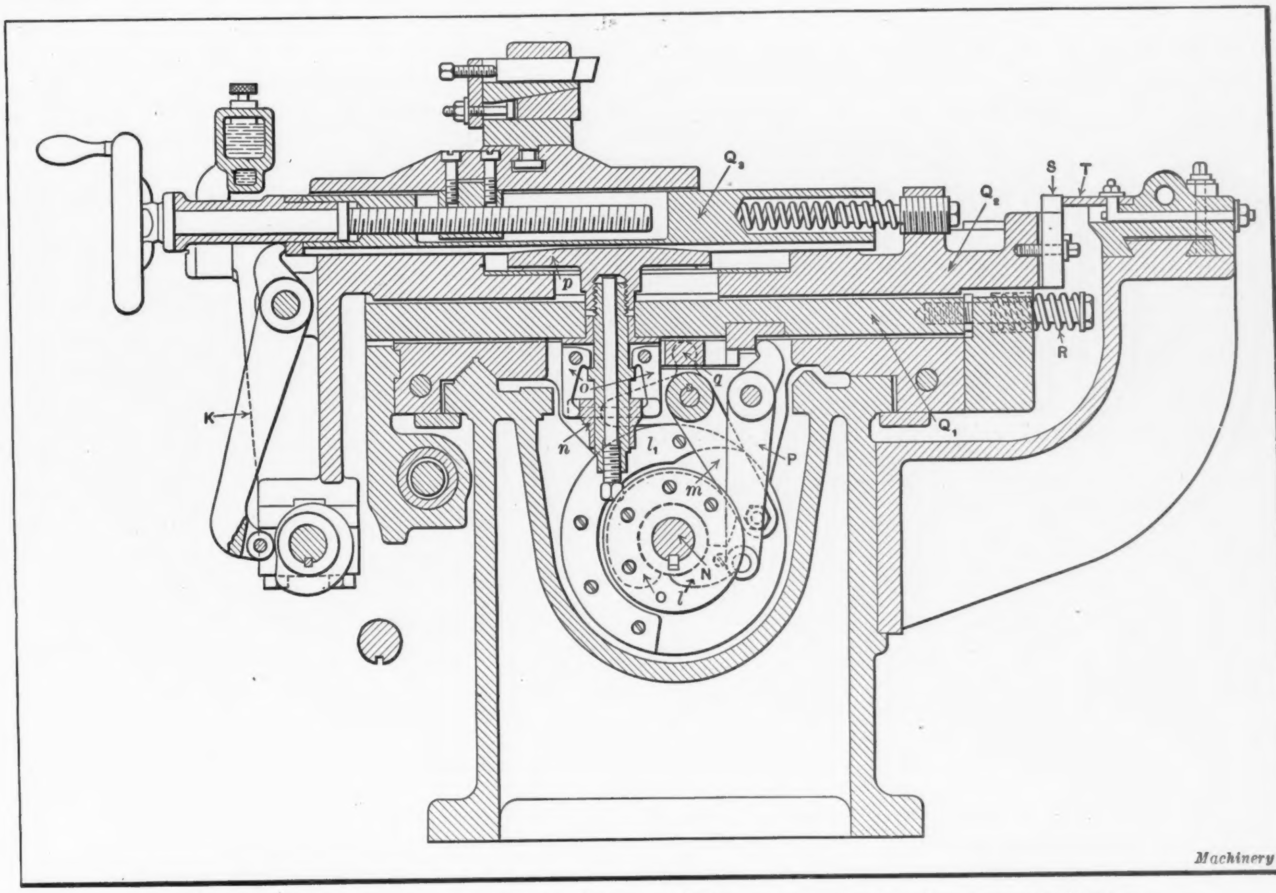


Fig. 12. Cross-sectional View, showing the Means of adjusting and clamping the Three Cross-slide Members

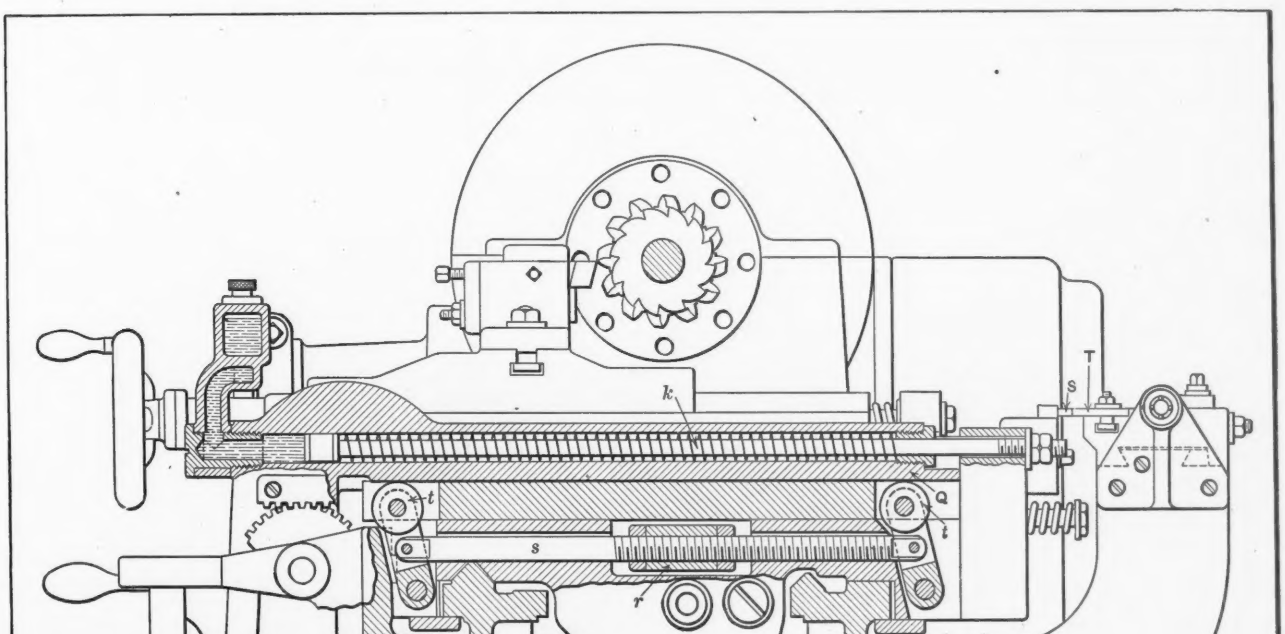


Fig. 13. Cross-sectional View, showing Means of returning Tracer Point to Templet without Vibration

on the machine for relieving a milling cutter. Of course. this is only a "stunt" to demonstrate the sensitiveness of the operation, as the ordinary templets are made of steel. During the return movement of slide Q_2 by spring k, slide Q_1 is independently returned by spring R.

Features of the Cross-slide Operating Mechanism

Having stated the conditions that are required in adjusting the cross-slide mechanism, we are ready to explain the means by which the required result is accomplished. Carried on shaft N, Fig. 12, there is a second cam l that operates a lever m which is in the form of a bellcrank. At the opposite end from the cam roller, this bellcrank carries a yoke that engages a tapered block n and provides for pulling this block down between two clutch fingers o, or for raising the block, as required. This clamp pulls a strap p down on top of slide Q_2, locking it in position on slide Q_1; and as slide Q_3 is carried by slide Q_2 it will be apparent that all three slides are connected by this action. The reverse movement of bellcrank lever m by the cam l_1 releases the slides. At the time that it is required to release the clamp in order that slide Q_2 may move over slide Q_1 through the action of spring k, cam l_1 moves the roller on lever m in the opposite direction, thus raising taper block n from between fingers o and lifting strap p out of contact with slide Q_2. At the same time, a projection q on the lever m throws over a strap r, Fig. 13, and through two rods s and auxiliary links, slide Q_3 is raised on rollers t so that it may be moved freely through the action of spring k. At or about the time that the former pin S comes into contact with templet T, thus checking further movement of slide Q_2, the roller on lever P, Fig. 12, runs down a decline on cam O and allows spring R to move slide Q_1 back to its starting position. Then the roller on lever m runs up the rise on cam l and pulls down block n so that the clamping jaws o and strap p may lock the two members of the cross-slide together to form a single unit.

A description of this adjustment of the position of the cross-slides would be incomplete without making reference to the way in which provision has been made for adjusting the mechanism that oscillates the relieving slide Q_3 for different relative positions of the two cross-slides Q_1 and Q_2. It will be apparent from Figs. 7 and 12 that the camshaft bracket, the cam-lever K, and all auxiliary mechanism for obtaining the required oscillatory movement is carried at the front of slide Q_2, and that power must be transmitted to this mechanism from a horizontal shaft running in bearings secured to the front of the machine. To allow the drive to be effected, regardless of the transverse position of the cross-slide Q_2, it will be seen that there is a splined shaft u that slides through one of two bevel gears transmitting movement to the camshaft that rocks lever K, from which motion is transmitted to the relieving slide. With such a transmission, a transverse movement of the cross-slide does not cause any trouble. The operation of relocating and clamping the slides requires but a few seconds, and then the main driving clutch at the back of the machine is again reversed to start the spindle rotating for the performance of the next cycle of operations.

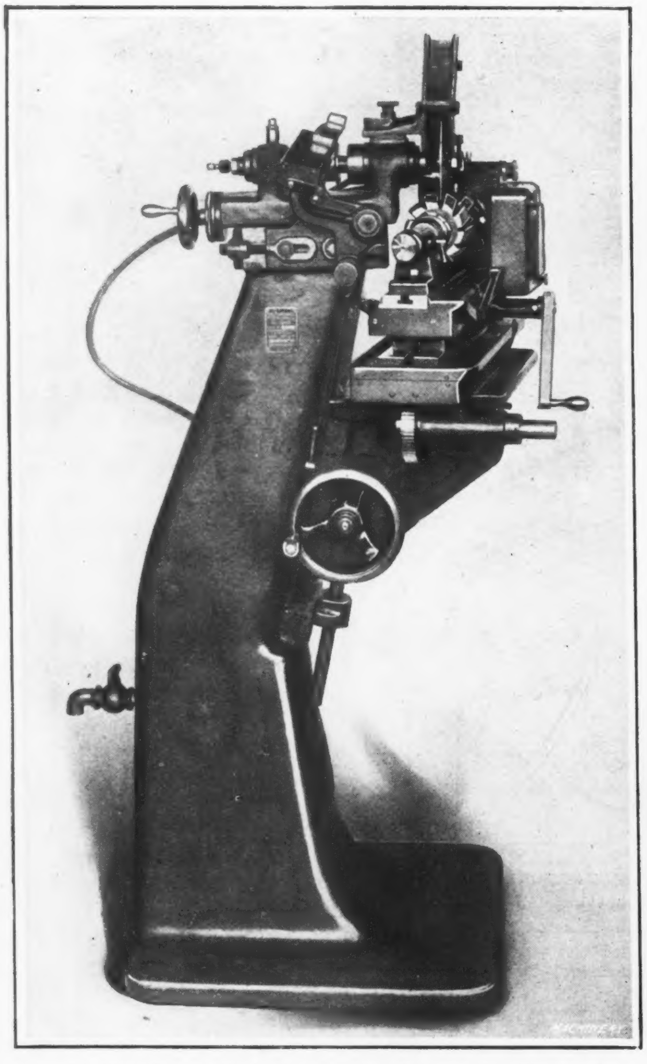


Fig. 14. Side View of Cutter Grinding Machine, showing how the Table is moved Parallel to the Face of the Conical Wheel

Fig. 15. Front View of Cutter Grinding Machine, showing Hand-operated Lever and the Grinding Wheel in Operation on a Cutter

Special Cutter Grinding Machine

In addition to the development by Mr. Müller of the special machines for relieving "curvex" milling cutters, it was also found necessary to provide a tool-grinder adapted for sharpening them. The machine used for this purpose is illustrated

in Figs. 14 to 16. It is equipped with a grinding wheel having a conical grinding surface which presents only a single element of the cone to the face of the cutter flute that is being ground, so that there is but a single line of contact between the wheel and work at any one time, and the wheel is able to follow the helical path of the flute to grind the cutting edge to the required form. There is nothing particularly unusual about the actual tool grinding operation, but the design of the machine has been carefully worked out to provide for truing the grinding wheel to the required form and for adjusting the position of the wheel to compensate for the reduction in size of the wheel that occurs during the truing operation. The theoretical grinding line is always in the same relation to the position of the work, notwithstanding the reduction in the wheel.

The design of the machine also permits the table to be raised or lowered to compensate for different diameters of cutters to be ground, the arrangement being such that this adjustment does not interfere with the relative position of the theoretical grinding line. Referring first to the side view of the tool-grinder shown in Fig. 14, it will be seen that the knee on which the table saddle is carried is supported from an inclined bearing on the column, the angularity of which brings its face parallel to the face of the conical grinding wheel when it is held on a horizontal arbor. Of course, the grinding wheel is so located relative to the line of centers on which the cutter arbor is supported, that the previously mentioned line of contact between the grinding wheel and the cutter coincides with a radius of the cutter. The theoretical grinding line is therefore always in the same relation to the axis of the cutter to be ground regardless of the elevation of the table.

At the right-hand end of the machine, Figs. 15 and 16, it will be seen that there is an ordinary index-plate which is arranged with circles having different numbers of holes to provide for indexing cutters with various numbers of flutes. In order to grind each flute to conform to the required helical path, it is necessary to impart a combined traverse and rotary movement to the cutter. This result is accomplished by reciprocating the grinding machine table in the usual way, and at the same time, imparting the reciprocal rotary movement to the cutter that is being ground. The table movement is operated by a hand-lever which traverses the table by means of a rack and pinion. Secured to the machine there is also a stationary rack which meshes with a pinion carried by the mechanism at the right-hand end of the table. This pinion transmits power through a set of change-gears *v*, Fig. 16 to a worm meshing with a worm-wheel on the live center that supports the cutter arbor. In this way, provision is made for imparting the necessary reciprocal rotary movement to the work for grinding the helical flutes; and by changing gears it is possible to adjust the machine for grinding cutters with flutes of various helix angles.

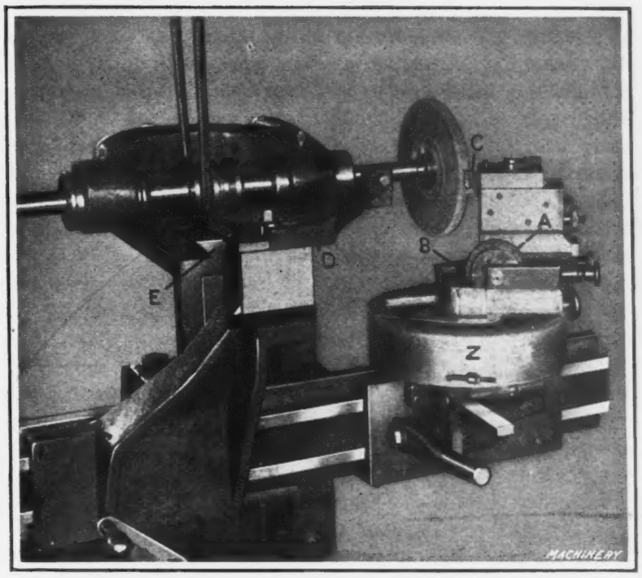


Fig. 17. Close-up View of Top of Special Grinding Machine for grinding Relieving Tools and Tracer Points to the Required Form

Provision for Truing the Grinding Wheel

It has already been mentioned that the line of contact between the wall of the cutter flute and the grinding wheel intersects the line of centers on which the cutter is supported, and it is important to maintain this relationship. Hence, the diamond wheel-truing tool on the machine must be carefully adjusted for this purpose. Fig. 16 illustrates the method of procedure. A steel disk *w* of the same size and form as the grinding wheel, is set up in place of the wheel, and a test arbor with a knife-edge gage *x*, arranged to intersect the line of centers, is set up between centers on the machine. Gage *x* is then brought into contact with steel disk *w* and the transverse slide carrying the disk is adjusted until gage *x* contacts uniformly with the disk for its full length. It will be seen that the wheel-truing device *y* is carried on a pivotal support, so that it may be swung back away from the wheel except at such times as it is required to dress the wheel. Then the bracket is swung down so that the diamond point may be traversed back and forth across the inclined wheel face. The reciprocal slide on which the diamond is mounted, is inclined at such an angle that the diamond point follows the inclined face of the wheel. When first setting the diamond, it is brought into engagement with the steel disk *w*, located as before described. After once being set, no adjustment of the diamond is necessary except to compensate for wear of the diamond itself. After the diamond has been thus set, the disk *w* is removed and the regular grinding wheel put in place and trued. It will be clear that as a result of the foregoing arrangement the grinding line of the wheel intersects the axis of the cutter to be ground. In subsequent truing operations, the wheel is moved up to the diamond so that the previously mentioned grinding line remains unchanged.

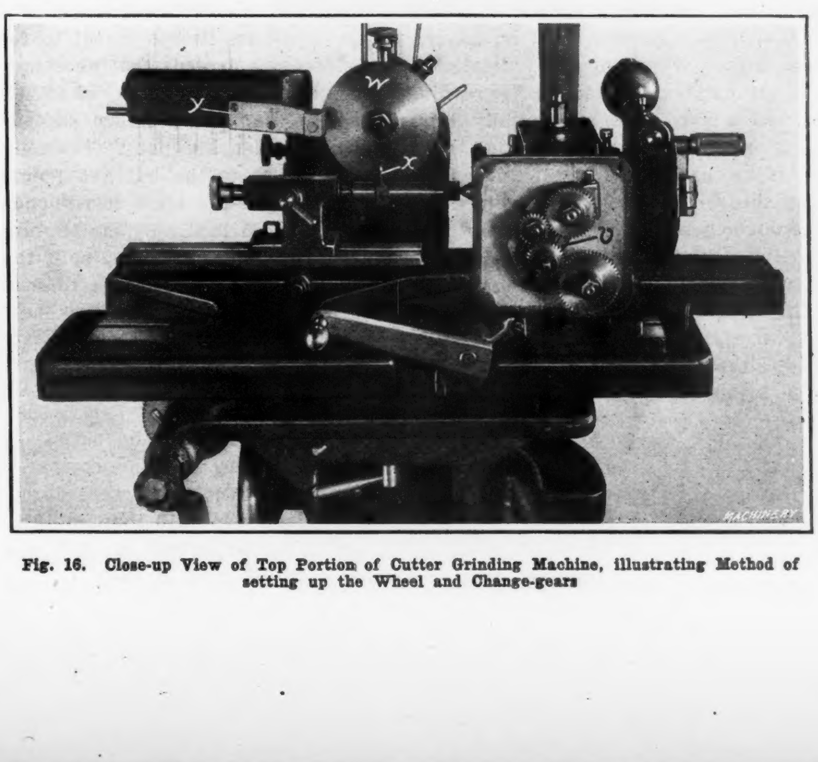


Fig. 16. Close-up View of Top Portion of Cutter Grinding Machine, illustrating Method of setting up the Wheel and Change-gears

Forming Tracer Points and Cutting Tools for the Relieving Machines

In an earlier section of this article mention was made of the fact that it is necessary to have the relieving tool used on this backing-off machine of exactly the same form and size as the tracer point following the master cam that governs the form of the milling cutter. For producing these two tools, use is made of a special grinding ma-

chine shown in Fig. 17. The tool to be ground is carried by floating tool-block *Z*, and the problem consists of providing means for oscillating this tool-block so that the point of the tool will be ground to the required radius of curvature. This result is accomplished by means of a cam *A* which is made with a large number of cam elements of different radii of curvature distributed around the circumference of a disk. The cam may be set with any of these elements in contact with a hardened anvil *B* so that the floating tool-block may be oscillated with the cam constantly in contact with the anvil, thus providing for grinding the tool *C* that is in contact with the abrasive wheel to duplicate the form of the cam. The wheel is carried by a head *D*, which slides on a guideway *E*. Were it not for the necessity of providing clearance for the cutting tool, this would be a very easy grinding operation to perform as it would merely be necessary to provide the cam with the form desired for the tool. But when the tool is set at an angle, as shown in Fig. 17, in order to produce the desired clearance, it will at once be apparent that the form of the ground piece is slightly distorted. A correction is made for this condition by carefully shaping the cam so as to compensate for the distortion.

Features of "Curvex" Milling Cutters

In relieving the teeth of a milling cutter with helical flutes, the backed off surface of the tool is distorted in a way that prevents the work milled by the tool from fitting the tool, although it is an exact duplicate of the templet which guided the backing-off tool while the milling cutter was being relieved. At first, it may appear strange that a milling cutter is able to reproduce a required form, although that form does not correspond to the contour of the cutter for any cross-section through the axis of the tool. As a matter of fact, such a result is to be expected, when it is borne in mind that only one point on the cutting edge is in operation at a time and that the test made by laying the work against the tool has no significance, because it is not generated by points along the cutting edge of the tool working simultaneously, but through the progressive action of these points coming into contact with the work one after another. From Fig. 3 an idea will be obtained of the variety of "curvex" milling cutters which has been produced, although these examples by no means fix the limits of the forms of cutters that can be produced by this method.

* * *

Plans are under way to celebrate the fortieth anniversary of the American Society of Mechanical Engineers on November 5 by providing for the holding simultaneously of forty sectional meetings of the society membership.

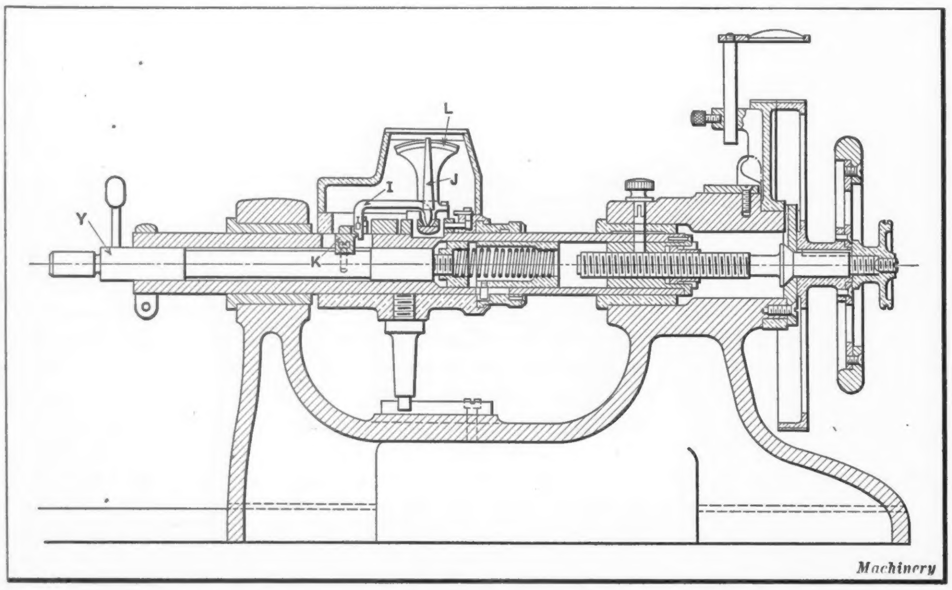
THE S. I. P. PRECISION MEASURING MACHINE

By ASHER GOLDEN

The writer has read with interest the description on page 135 of the October number of MACHINERY of an improvement on the indicator of the Newall measuring machine. The object of this improvement was to overcome the viscosity of the liquid in the level tube, which caused the movement of the bubble to lag. It is stated by the author that if wires were placed in the machine and rotated, the bubble in the level was slow to show variations in diameter of 0.00005 inch. It is claimed that the improvement shows variations of roundness of 0.00001 inch.

The indications of a measuring device are valueless for high-precision work unless the human element can be either completely eliminated or else corrected. It is for this reason that measuring machines are designed with some form of indicator that will make the readings independent of the touch of the operator. It is the writer's belief that the only measuring machine so far designed that completely eliminates this factor is the S. I. P. machine made by Société Genevoise d'Instruments de Physique, of Geneva, Switzerland.

As shown by the accompanying sectional view this machine has two multiplying levers *I* and *J*. The lever *I* is actuated directly by the hardened block *K* attached to the rod *Y*, the end of which forms one of the measuring points. The multiplying ratio of the two levers is 1 to 1000. The scale *L* is graduated in twentieths of an inch. The scale has its 0 at the middle with ten divisions to the left and ten to the right. When the measuring face is not in contact with any object being measured, the indicating needle *J* appears at the extreme left or minus end of the scale.



Sectional View of the Measuring Machine made by the Societe Genevoise d'Instruments de Physique

If the two measuring points of the machine are brought close together or against a gage or other object being measured and the right-hand measuring face (not shown in the illustration), is slowly brought up so as to make contact, the indicating needle moves over the scale to the right. When the needle points to 0, the pressure is about one-half pound. It is in this position that all readings are taken. If the right-hand measuring point is still further advanced, the needle continues its movement to the right and indicates that the pressure exceeds that necessary for taking the readings. If the measuring points, when set, are accidentally brought up so that the pressure exceeds one-half pound, the right-hand measuring point is simply backed off until the indicator shifts to the left and points to 0. A movement of one division of the scale corresponds to a movement of the rod *Y* of 0.00005 inch. By the application of a magnifying lens it is a simple matter to split the divisions into five parts, thus enabling the operator to read to 0.00001 inch.

* * *

The falling off in working efficiency on the part of industrial workers is noted all over the world. The British statistics on coal mining show that in 1913 the output of the British coal mines was 287,000,000 tons as compared with only 230,000,000 tons in 1919. Yet there were 63,000 more people employed in the industry in 1919 than in 1913. In terms of productivity per man, the output in 1913 was 332 tons per man as against only 253 tons in 1919.

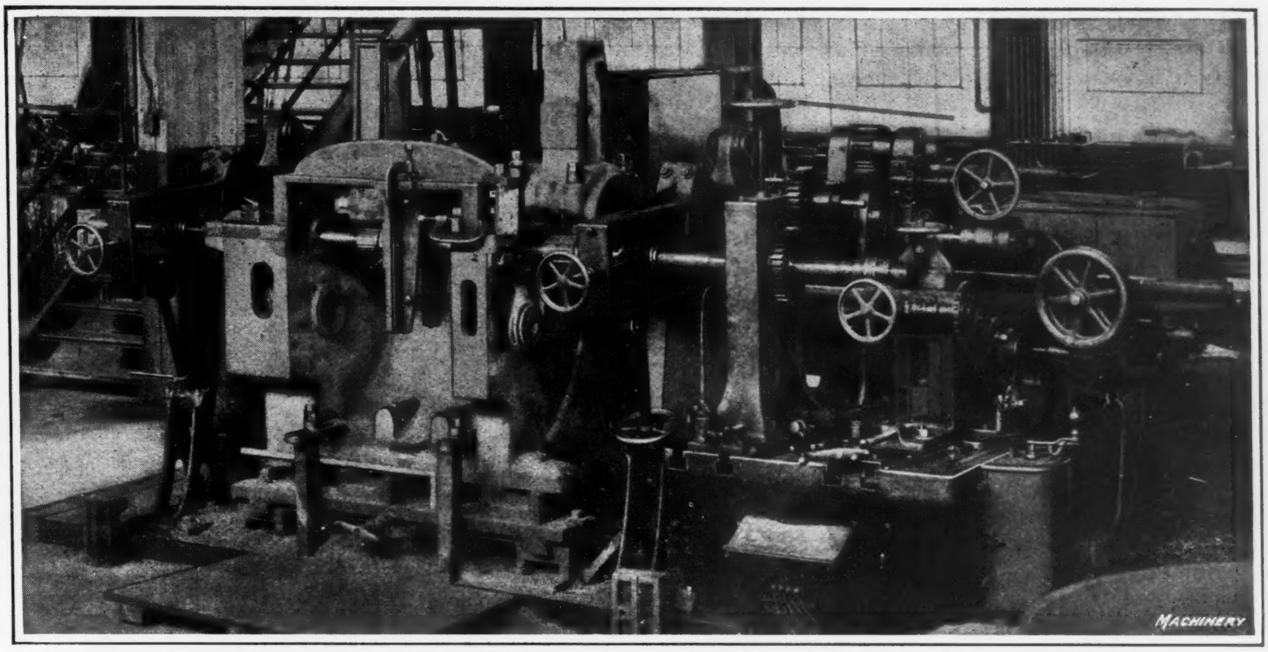


Fig. 1. Horizontal Boring Machine designed for Boring, Reaming and Facing Operations on Lathe Headstock and Tailstock Castings

Heavy-duty Boring Machine

Machining Headstock and Tailstock Castings for Ninety-inch Driving Wheel Lathes

THE special horizontal boring machine illustrated in Fig. 1 is used in the Putnam Machine Works, of Manning, Maxwell & Moore, Inc., Fitchburg, Mass., for machining headstock and tailstock castings for 90-inch driving wheel lathes. The machine is driven by a 7½-horsepower constant-speed motor direct connected to the main spindle boring-bar, from which by means of suitable gear trains, an auxiliary boring-bar is driven. This bar is supported by two adjustable bearings carried in suitable swing arms at each side of the casting. Handwheel adjustment is provided for locating these arms at the proper angle and also for adjusting the bearings radially. In the illustration Fig. 1, this boring-bar is set up for machining holes *D* and *C*, Fig. 3.

It will also be seen by referring to this illustration of the headstock casting, that provision for machining holes *E* and *F* requires that the bearing arms be not only swung downward but also that the adjustable bearings must be set at a greater radial distance than would be possible if this adjustable feature were not provided. It should be stated that this illustration is not a fully dimensioned drawing and that only those dimensions are shown which will enable an idea of the size and proportions of the castings to be had and the relative position of the holes being machined. When making the adjustment before machining holes *E* and *F*, the journal box carried in an upright bracket (at the gear end of the machine) attached to the base, may be lowered by means of another handwheel adjustment, and the bracket adjusted transversely to accommodate the setting necessary for the operations on the second pair of holes. This change of center distance requires changes in the gear train, which the transmission mechanism suitably provides for. An inspection of the illustration Fig. 1 will enable the construction to be quite plainly seen as well as the method of clamping the casting to the machine table. Transverse adjustment is provided for convenience in locating the work-table when setting up the work. The handle which operates the cross-screw, by means of which this transverse movement is accomplished, is shown near the floor, on the front of the machine. It will be noticed that there are two fixed bearings, located at the rear of and above the spindle boring-bar; these are used on headstocks of a slightly different model than that illustrated. This machine, when set up for machining tailstock castings, does not require the use of the swing arms, and in such cases the boring-bar is removed and the arms are lowered.

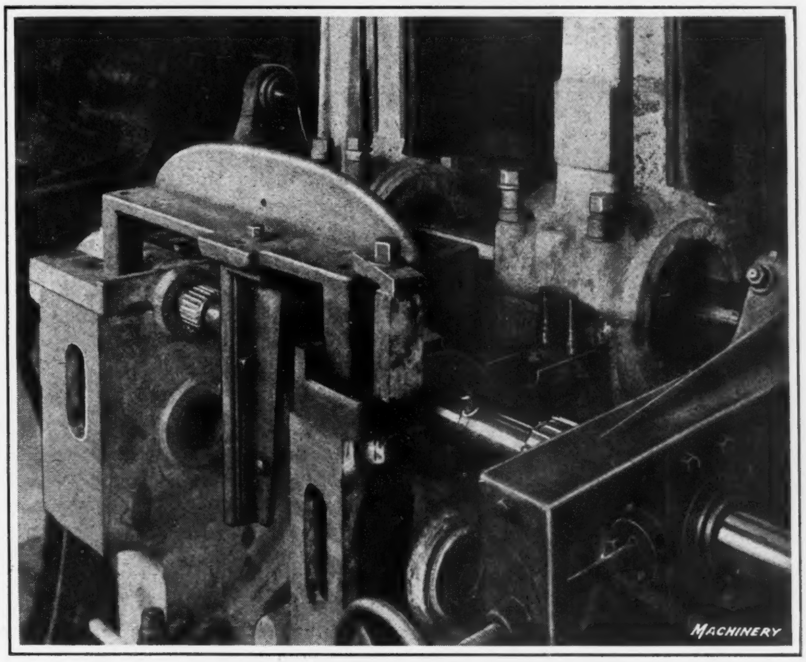


Fig. 2. Close-up View of the Work showing Boring-bars with Reamers and One Tool

In setting up the machine for these operations, the bearing caps are assembled and an arch bracket is clamped to the caps for holes

C and *D*, Fig. 3, from which a center bearing is attached to stiffen and maintain perfect alignment for the boring-bar. This arch bracket is prominently shown in Fig. 2. The work performed on the headstock casting, Fig. 3, consists of boring and reaming the three holes *A*, *C*, and *E*, in the front wall and holes *B*, *D*, and *F* in the back wall of the castings, and facing both sides of the bosses through which these holes pass. The spindle holes *A* and *B* are finished to 14 and 10½ inches in diameter, respectively. The finished diameter of hole *C* is 6 inches; of holes *D* and *E*, 4½ inches; and of hole *F*, 6⅝ inches. The length of each of these holes is indicated in Fig. 3.

Fig. 2 is a close-up view of the tooling set-up, showing the boring-bars and the tool used in boring hole *C*, as well as the two shell reamers carried on the boring-bar, with which both this hole and the other back-gear shaft hole *D* are simultaneously reamed. It will be evident that this smaller bar is fed through the work, whereas the boring-bar for the main spindle holes is provided with a feed-screw by means of which the tools for boring both bearing holes are fed along the bar during the operation.

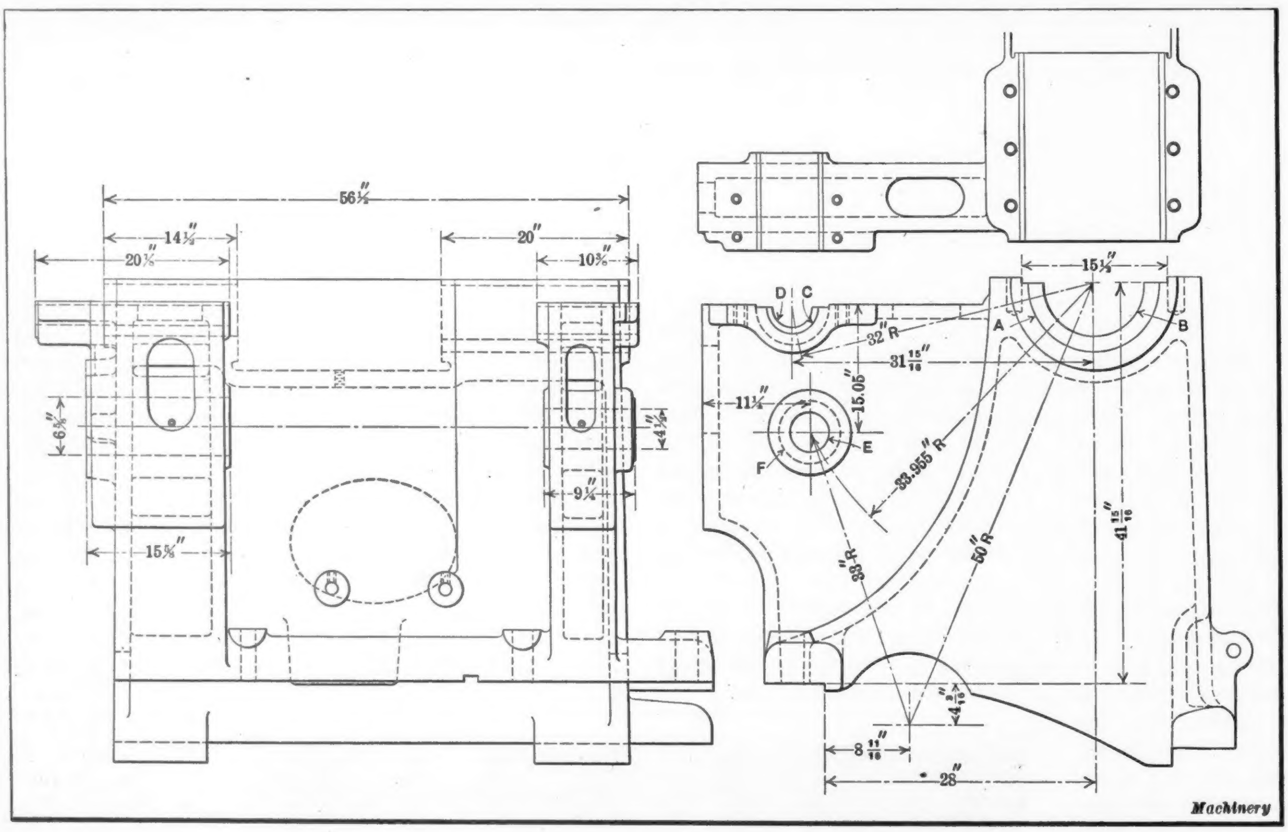


Fig. 3. Partially Dimensioned Drawing of Headstock Casting, on which are indicated the Holes machined on the Boring Machine

In the facing operations on the bosses for all these holes the boring-bars are utilized for attaching the familiar type of star-wheel cross-feed mechanisms. Thus, after the castings have been once set up on the machine, assurance is given that all holes will be machined parallel and in the proper relation to each other, and that the bosses will be faced so as to register square both with the holes and with the base of the casting. The time required to finish headstock castings of the design shown is approximately thirty-two hours, including setting up the work. This time element cannot be stated exactly, since irregularities in the casting and the earlier operations on the base and caps are likely to add somewhat to this in the setting up of the work. For this reason, a maximum time consumption of thirty-six hours is allowed.

* * *

It has been estimated that the total value of machine tools built in Great Britain during 1919 was about $40,000,000 at present exchange rates.

WHAT IS REQUIRED TO CONSTRUCT A MODERN AIRPLANE

The number and variety of parts entering into the construction of a modern airplane is far greater than the engineer or mechanic engaged in other lines of production would think. The following is a list of the parts required to build a De Haviland four-cylinder plane: 2608 wood parts, only 608 of which are alike in shape; 1665 sheet-metal parts, of which 1500 differ in shape; 20 different forgings; 139 different tubes; 78 different castings; 5335 bolts and machine screws, of which 1500 differ from each other; 1589 nuts of 50 different styles; 1213 washers of 100 different styles; 10,675 wood-screws of 150 different shapes and sizes; 8609 nails, tacks, etc., of 150 different shapes and sizes; 659 wires of 20 different kinds; 87 terminal standards of 40 different shapes; 750 small metal parts of 300 different shapes; 366 pieces of linen, of which 50 are different; 12 bearings; 474 items of equipment, including military equipment, of which all but 4 are different; 343 miscellaneous parts, of which 300 are different.

In addition, there are many such articles as bakelite, cellulose fiber, fabrikoid, felt, glass, leather, rubber, rawhide, and transparent sheets. There are also required 128 yards of linen, 827 yards of silk thread, 215 yards of special cotton tape, 440 yards of cotton twine, and 168 yards of linen twine. Allowances for waste or spoiled material have not been included in these figures. Moreover, each plane requires 110 gallons of shellac, varnish, and dope. The 2608 pieces of wood include 664 pieces of veneer, 1586 pieces of spruce, 152 pieces of ash, 36 pieces of walnut, 6 pieces of maple, 24 pieces of hickory, and 140 optional pieces of different hard woods.

* * *

The Italian Government has made a ruling forbidding the Italian automobile factories to sell more than 10 per cent of their total product in Italy. The remainder of the production must be exported. It is expected that through the export trade thus created, an improvement in the exchange situation may be effected.

Service Department in a Machine Tool Plant

An Outline of the Purpose, Organization, Equipment, and Methods of the Service Department of the Heald Machine Co., Worcester, Mass.

THE successful manager of a machine shop today, in purchasing new equipment, does not look merely for a certain type of machine tool; what he wants is productive capacity. He feels that he must go into the problem deeper than merely to find out that a machine will perform a certain operation. Service departments have been developed rapidly in recent years in the organizations of various industries, but probably nowhere do they serve a more helpful purpose than in the machine tool industry. This fact is due to the long life of machine tool equipment and to the continuous loss to the owner when unsuitable equipment is installed.

The machine to be selected for a given purpose is the one which will furnish the largest output in proportion to the factors of first cost, operation cost, overhead, maintenance, and depreciation. In so selecting a machine, it has become common practice for the prospective purchaser to obtain definite estimates or guarantees with regard to the production he will secure on his particular work. Production managers frequently find wide differences between the production estimates given by representatives of different machines of the same type; this is due usually to the different way in which these estimates are made. The careful manager will naturally have greater confidence in estimates given out by a service department organized for such work, than he would in those derived by less systematic means.

How Dependable Service may be Rendered the Prospective Machine Tool Purchaser

In order that the machine tool manufacturer may make accurate estimates and guarantees, it is necessary for him to maintain a service department; and to assure the meeting of these guarantees by the machine when installed in the customer's factory, experienced operators must be employed to assist the customer in starting these machines and to instruct the man who is to run the machine with regard to its handling and adjustments. These skilled operators or demonstrators, being present when the machine is put in operation in the customers's shop, are in a position to see that the expected results are obtained.

A highly developed service department operating along these lines is maintained by the Heald Machine Co., Worcester, Mass. The department is composed of two main divisions: An engineering section with its engineers, designers, and service shop, and a division consisting of a field demonstrating force of experienced service representatives. The engineering section employs a number of draftsmen whose time is given over entirely to the designing of work-holding fixtures and to the study of the best grinding and holding methods for each individual case. It also operates a small shop equipped with one of each type of machine built by the Heald Machine Co. In this shop, a partial view of which is shown in Fig. 1, there are installed two cylinder grinding machines, three internal grinding machines, and two rotary surface grinding machines, with a variety of magnetic chucks. In addition to the machines, there is a stock of several thousand grinding wheels, having a wide range of combinations of grit, grade, abrasives, size, and shape. This complete line of wheels forms a working stock from which it is possible to select the most efficient wheel for any kind of work without the necessity of making allowances or waiting for the delivery from the wheel manufacturer of a wheel such as required before the operation can be tried out.

With this equipment available, it is an easy matter for the service department to run off 5, 50, or 500 pieces of any particular kind that may be sent in by a prospective customer in order to determine accurately what speed should be used in handling the work, what accuracy the operator can regularly secure, and the degree of finish that wheels of various grades and grits will produce. It should be evident, therefore, that the recommendations of a service department so organized can be made conservative and correct, because this method of procedure enables the department to eliminate all guesswork when determining the productive rate.

The Engineering Department and its Work

In addition to test work done in the service shop, a complete record is kept in the engineering department covering the experience of other customers in their shops on similar work. These records include information received from the demonstrators concerning production secured in the different factories, as well as reports regarding the working out of the various types of jigs and fixtures used. The demonstrator's reports are carefully indexed and cover fully the nature of the piece, its size and shape, the method of holding, the amount of stock left for grinding, and the grade and grit of wheels used. With such information on hand, founded on experience, accurate estimates can be given to prospective customers. The department keeps on file complete sets of drawings covering fixtures that have been already made or designed for holding different kinds of work, so that by referring to these, a design which is suitable for

a new piece can often be found which will require only slight changes to meet the requirements of the work on which it is proposed to be used.

All correspondence which requires the attention of the engineering service department is delivered directly to the engineer in charge. In this way actual engineering thought and not merely clerical attention is given to these inquiries. If the question is a simple one which can be readily answered from the information available, a reply is sent immediately. Often the department already has on file definite information with regard to the output of such work and even blueprints showing a good method of holding. If such is the case, this information can be furnished promptly. In other cases, where the work is a new application or has additional difficulties, considerable time and study must be spent in handling the proposition and special jigs may have to be drawn up, and recommendations for the equipment decided on. Frequently the service department sends for samples of the work to be handled, and these are experimented with by an operator in the service shop. When this is done, accurate and complete information can, of course, be furnished.

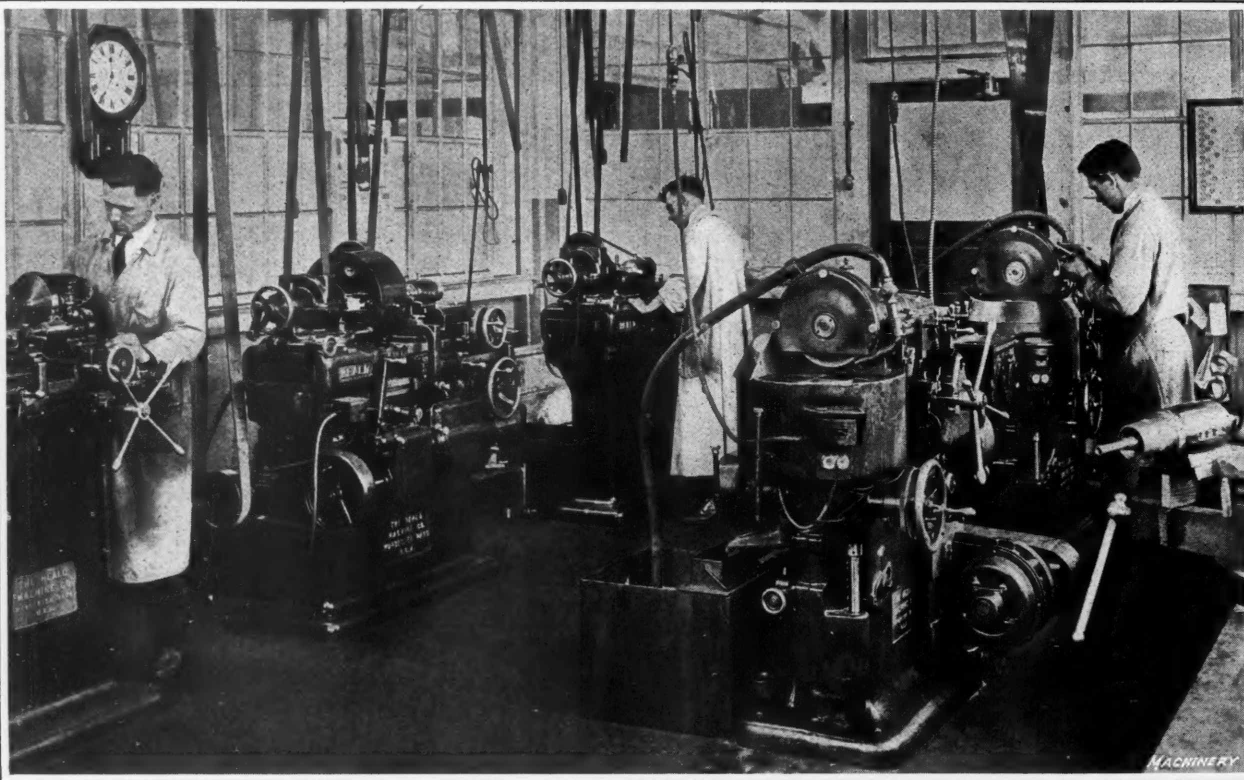


Fig. 1. Service Department in the Heald Plant where Work-holding Fixtures are tried out, Wheels determined upon, and Time Estimates made

The Demonstrator—his Duties and Difficulties

The foreman of the service shop is one of the company's most experienced demonstrators, and his knowledge of outside manufacturing conditions is of great value, not only in the test grinding, but also in assisting the operators of the service shop, who are being trained to become demonstrators. Demonstrators, thus trained, are fully competent and skilled operators. In addition to being a skilled operator, the demonstrator must also be a man of tact and judgment, and it is not always the most successful operator who makes the best demonstrator. It is the business of the demonstrators to see that the machines shipped are installed in the proper manner, so that the customer will secure the best results both as regards quality and quantity of production, and also to see that the methods developed by the engineering section are properly carried out in the customer's shop.

Usually the demonstrator goes into a shop where he is a total stranger and must proceed to start a machine, see that the speed of the countershaft is correct, determine whether the machine has been set up in the proper manner, and ascertain that the holding fixture, wheel-heads, and grinding wheels are correct. The demonstrator commonly finds that the speed of the countershaft is incorrect, in which case, it is his duty to see that different pulleys are secured for the main lineshaft to furnish the correct speed for the countershaft. The tactful demonstrator usually secures these changes without much difficulty. In a certain shop where six machines were in operation, the demonstrator found that the countershaft was running backward and that the entire machine, work-spindle, wheel-spindle, and even the pump were running in a direction opposite to that intended by the designer of the machine. This was actually an unsafe condition. Under such circumstances, no grinding machine could be expected to perform efficiently, and in order to realize the estimated production rate and quality of work, the demonstrator was required to correct this condition.

A common cause of failure to meet the production estimates has been found to be the allowance of an excessive amount of material for grinding. This is especially noticeable in cylinder grinding, in which it often becomes a serious matter. The cause may be due to poor boring, where a hole is produced that is not square with the face of the cylinder so that the wheel removes more metal at one end and less at the other end than it should. In order to rectify such troubles, the demonstrator usually has to investigate the boring operation, and as a result, the boring machine must be trued up in order to produce work which can be ground efficiently. It will be appreciated that the demonstrator is liable to encounter numerous difficulties and be considered a meddler in attempting to rectify such conditions. A good demonstrator is, in a certain sense, an efficiency engineer in the customer's factory, and the customer therefore secures not only a machine tool, but engineering experience and assistance of the most valuable kind when he purchases a machine which is installed under a service system.

Breaking in New Operators

Another factor which tends to reduce production, and for which the manufacturer of the grinding machine is sometimes wrongly held accountable, is the changing of operators. While it is unreasonable to expect the manufacturer's assistance for troubles of this kind, it is frequently demanded,

and a demonstrator is sent for, although all he is called upon to do, upon arrival at the shop, is to break in a new operator. In many shops it has been found that the machines are not treated as they should be; oil of the recommended viscosity is not used; proper speeds are not employed; the required adjustments are not made; and in many cases the machines are not given the proper care and attention. When such conditions are permitted to exist, an unfair advantage is taken of the manufacturer who is endeavoring to give a reasonable amount of attention and service to all his customers.

Following up Installations of Machines

The service department plans to have a demonstrator follow up every machine that is sold, to make sure that the machine is properly installed, that the workman is instructed as to the operation and care of the machine, and that any special fixture and tool work has been properly attended to. This is an important item, because it is a good deal easier to start an operator in the right way than to get him to change to some other method of doing the work after he has been running the machine according to his own ideas for a month or more. Frequently, too, different work is ground on the machine from what had been originally planned when it was bought. In that case, a wrong size of wheel-head may have been furnished, and the customer may, for example, be trying to grind a hole 3 inches in diameter, when the wheel-head is only suitable for holes 3/4 inch in diameter. In that way production is kept down and there is dissatisfaction as to the output, whereas the trouble is due to the fact that the proper equipment for that particular job is not being used. The demonstrator can straighten this out quickly and agreeably if he arrives promptly after the machine is installed.

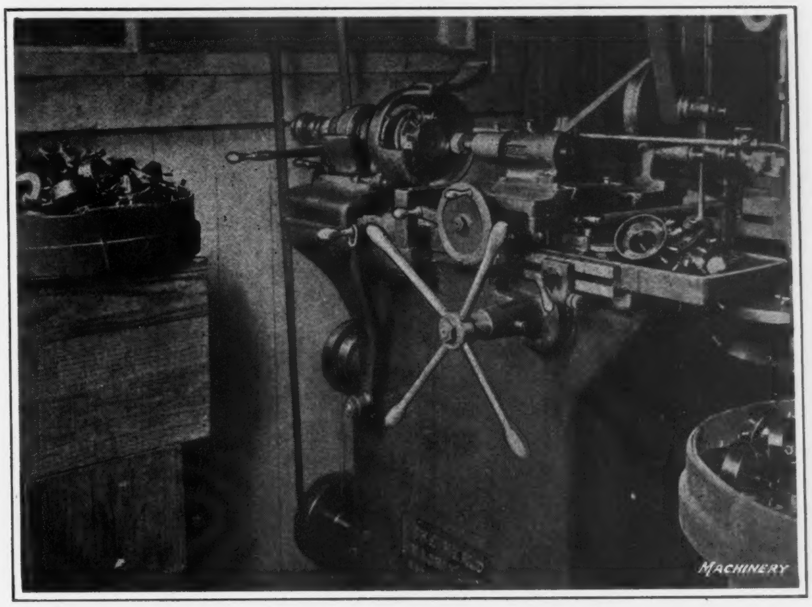


Fig. 3. Method of grinding Condensite Timers determined upon in the Service Department as shown in Fig. 2, in Use in the Customer's Shop

The demonstrators are distributed over a wide territory and are usually subject to the direction of the branch managers located in the territory where they are working. Several of the demonstrators are located permanently away from the factory, while others come under the direction of the main office in Worcester. In some of the branch offices, a stock of repair parts as well as complete machines is carried so that the demonstrator can secure from the nearest supply source the parts that he may need in caring for machines that have seen hard service.

Conclusion

Unfortunately all customers do not appreciate what this service means to them, or what the efforts and care involved in assuring them conscientious service after the machine is installed mean to the builder of the machine. The service department is, to a large extent, non-productive, because there is often no direct return for the amount of labor put into any particular job handled by the department. The prospective customer is under no obligation to purchase machines or equipment because of the experimental work performed in his behalf, but in the majority of cases the information and recommendations are found to be so worthy of favorable consideration by the customer that orders for the equipment recommended follow. The customer cannot help but have a certain amount of confidence in following these recommendations, knowing the amount of work and study that has been put into them.

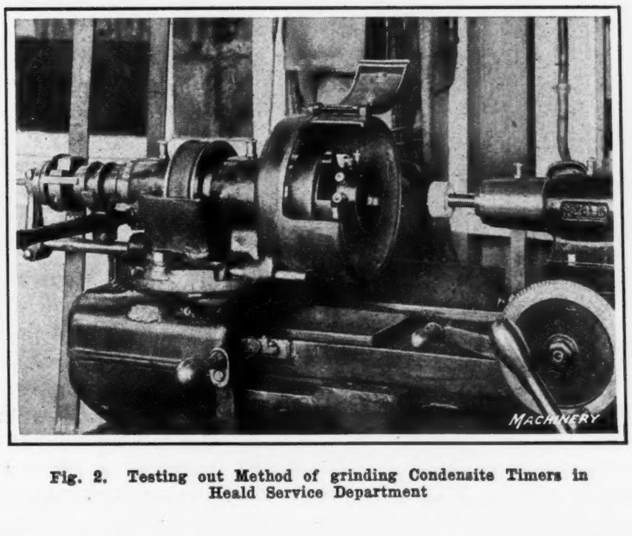


Fig. 2. Testing out Method of grinding Condensite Timers in Heald Service Department

While it may be generally true that the primary purpose of service departments is sales promotion, the department conducted by the Heald Machine Co. works with the underlying idea of finding out and suggesting the best way to do things to secure maximum efficiency and to have the recommendations take the form of actual efficiency engineering suggestions. Naturally, service of this type is conducive to increased sales for the company that makes the effort and the expenditure involved, and that gives the users of its product the full advantages of a complete engineering service department.

* * *

GASOLINE AND LUBRICATING OIL PRODUCTION

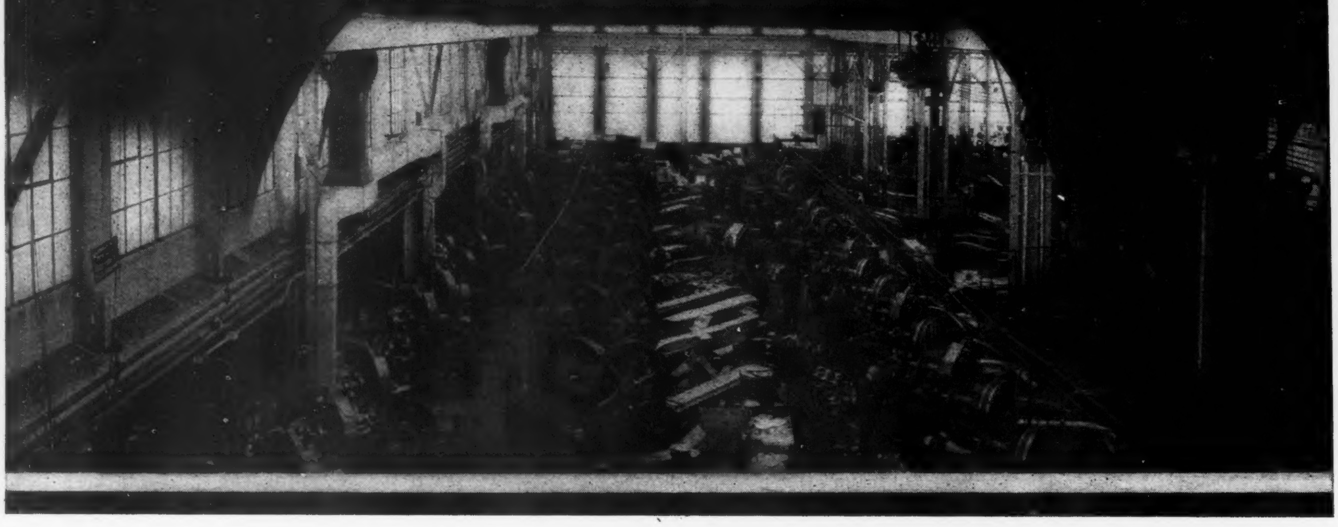
Approximately 13 per cent more gasoline was produced during the first six months of the present year than in the corresponding period of 1919. The domestic consumption in the first half of 1920 was 28 per cent greater than in the same part of the preceding year, while the total consumption was 32 per cent more.

According to the Bureau of Mines, the production of lubricating oils increased 22 per cent during the first half of this year, but the stocks on hand were lowered due to an increased consumption of 35 per cent. The export of lubricating oils was very great as compared with other petroleum products, representing 41 per cent of their total consumption during the first half of 1920. The increasing use of oil as fuel in ocean vessels is shown by the consumption of 100 per cent more bunker oil in the first six months of 1920 than in the same period of 1919.

* * *

The Interstate Commerce Commission has suspended until December 17, 1920, the new tariffs placing $10 demurrage charges on open cars held more than forty-eight hours.

Press Work in an Electric Motor Plant



First of Two Articles Describing Methods Used in the Power Press Department of the General Electric Co., Lynn, Mass.

By FRED R. DANIELS

THERE is probably no industry in which power presses play a greater part than in the manufacture of electrical equipment. The armature and field of the motor, —or the rotor and stator—are composed of laminated stampings of various shapes and sizes. These, together with the numerous switch boxes, gear covers, and similar drawn parts, constitute an interesting collection from which a few examples have been selected for the purpose of describing the dies and other special mechanism employed in the production of these parts.

To a considerable measure, the punching out of the numerous slots and holes in motor stampings is, as of old, performed on notching presses, but with the advent of the sub-press, the single punch and the indexing device of the notching press are being gradually supplanted by the perfectly aligned multiple punch and die unit. Although accurate results are obtainable on the notching press and quite rapid production may be realized, the best results are obtained by the sub-press. The first cost of the sub-press and the difficulty of obtaining perfect alignment of the upper and lower members in manufacturing probably accounts for the retention, in part, of the notching press on work of this kind. The equipment described was chosen with an idea of presenting representative examples illustrating the manufacture of motor-accessory sheet-steel parts, the work being performed in the press department of the General Electric Co.'s plant at Lynn, Mass.

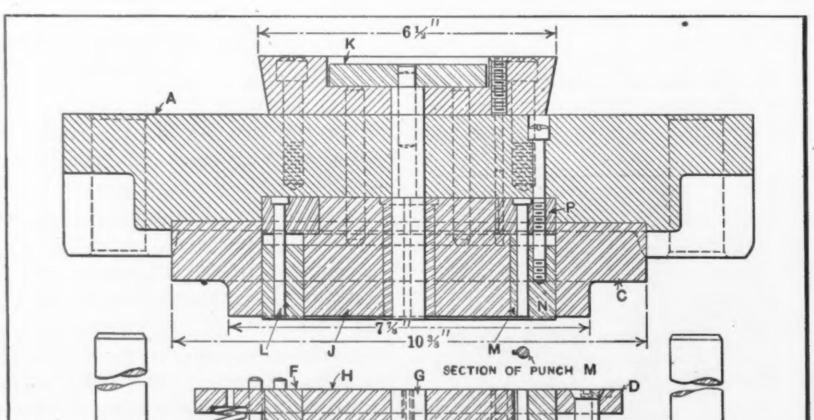


Fig. 1. Sectional View of the Sub-press Die shown in Fig. 2

Dies for Producing Stampings for Sewing Machine Motors

In manufacturing the stampings for a small sewing machine motor, known as the SA type, a series of four-pillar sub-presses is employed. Fig. 2 shows a view of the upper and lower members of the sub-press employed in the first operation. This is a full compound blanking die which produces the stator stamping shown at the right below the dies, and the rotor stamping in its first stage, as shown at the left. The dies used in the following operations are those employed in finishing the rotor stamping, the stator stamping being completed in one operation in the die shown. These stampings are made from sheet steel, 0.025 inch thick.

A sectional view taken through the center of the sub-press is shown in Fig. 1, from which the method of operation will be clearly understood.

The upper and lower holders *A* and *B*, respectively, carry all the operative parts and hold them in perfect alignment. This is the feature of sub-presses which makes them particularly suitable for the manufacture of laminations for electric motors. Barring very slight variations in the laminations due to wear on the cutting edges of the die,

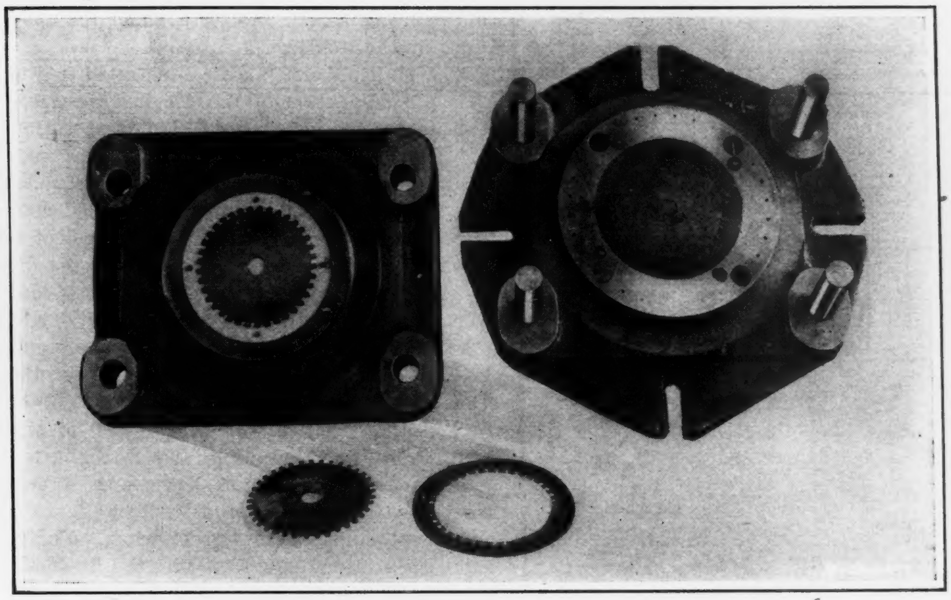


Fig. 2. Full Compound Blanking Die for producing Motor Stator Punchings

absolute duplicates can be produced, so that when assembled the laminations show no variation in contour or alignment of holes. In all the equipment here described, the upper and lower holders are made of cast iron; the punches, dies, and bushings of tool steel, hardened and ground; and the punch-plates, knock-out parts, and strippers, of machine steel. The upper holder carries die *C* and punch *J*, and between these parts the knock-out *N* operates. The feathered punches *M*, of which there are thirty-seven, and the four plain punches *L*, are attached to the punch-plate *P*, between which and the knock-out a space is provided to enable the knock-out to operate. The knock-out is operated by suitable pins extending through the upper member to the knock-out plate *K*.

Referring to the lower member, punch *G* is held fixed, so that as the ram of the press descends it will pierce the center hole in the blank and enter a steel bushing in the upper member, while the die *C* in passing down over the blanking punch *F* blanks out the stamping. Simultaneously, punches *M* and *L* of the upper member pierce the smaller holes in the work. An arrangement similar to that employed in the upper member is used to support the lower knock-out, and a corresponding opening between this part and the lower holder is also provided as the illustration clearly shows. As the knock-out *H* is permitted to descend when the spring-supported stripper *D* and knock-out plate *E* (on which the knock-out pins rest) are lowered by die *C*, space is provided for the feathers on punches *M* to protrude into the space that was formerly occupied by the knock-out.

Dies for Repunching and Trimming Rotor Stampings

The sub-press dies employed to perform the second operation on the rotor stampings are shown in Fig. 3, which also shows the appearance of the work before and after the operation is completed, while Fig. 4 is a detailed view of this sub-press. This operation is that of punching six holes. The dies employed are of simple construction; in the upper holder *A*, the punch-plate *C* is carried for holding six punches *D*. Between the punch-plate and the stripper *E*, the customary spring construction is employed. The three knock-out pins *H*, extending from the stripper to the knock-out plate *J* in the head-block of the upper holder, are a part of this familiar type of stripping mechanism. The three screws *K*, which maintain the desired alignment between the operative parts of the upper section of the sub-press, are provided with a locking arrangement for the nut so that as they operate through holes in the holder *A*, there will be no danger of turning and causing trouble. This construction is common to all the sub-presses described in which the strippers are attached by this method. The die-block or bushing holder *F* of the lower member carries suitable steel bushings in which the punches operate, and a locating pin *G* by means of which the blank from the previous operation is located by its center hole.

The third operation is performed with the dies shown in Fig. 6, and consists of trimming the blank and of punching three small holes near the center as shown in Fig. 5, which shows the sub-press employed in this operation and the appearance of the stampings before and after the operation is performed. Referring to Fig. 6, the upper holder *A* carries the trimming die *E* and the punch-plate *J* in which punches *D* are secured. The knock-out *F*, through holes in which the punches operate, functions through the familiar pin and knock-out plate arrangement incorporated in the equipment previously described. As the upper member descends, die *E* trims the blank with the aid of trimming punch *C*, on which the work is located by means of two pins, one for the center hole of the stamping and the other for one of the six holes previously punched. As the blanks are being trimmed, the narrow rings of scrap are forced down around punch *C* until they are severed by cutter *G* located in the lower holder. Since this sub-press was designed a series of vent holes has been added in punch *C* which do not show in the illustration. Fig. 5 shows the cutter and the locating pins previously mentioned.

Construction of Multiple Slotting Dies

The slotting operation performed on the blanks, in which a series of radial slots is punched, may be successfully performed with two different sets of dies of the sub-press type. The first of these is shown in section in Fig. 7 and also in Fig. 8, the latter illustration showing in addition, a view of the stamping before and after the work is performed.

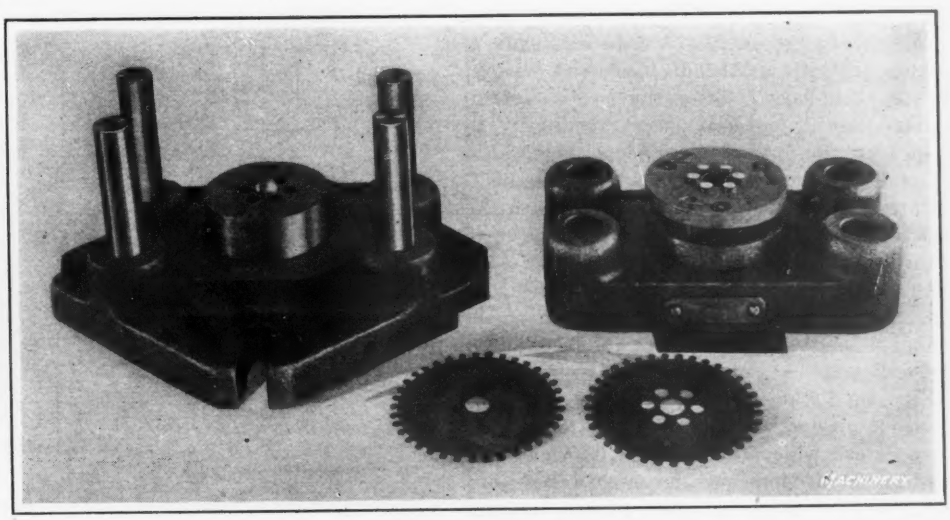


Fig. 3. Sub-press Die used for punching Holes in Sewing Machine Motor Rotor Stampings

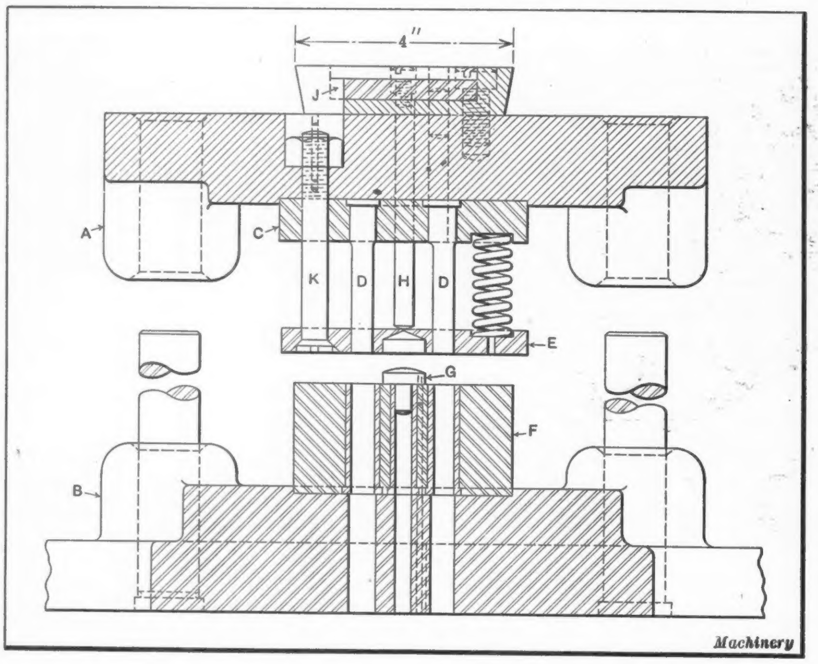


Fig. 4. Sectional View of the Sub-press Die shown in Fig. 3

This die is known as a two-stroke multiple slotting die; it differs from those used for similar operations in that an indexing feature is incorporated, so that only one-half as many die openings are required as would be the case with a single-stroke die of this type. This provides greater strength for the die sections, which otherwise would be rather frail unless this or some other means of reinforcing these die sections were employed.

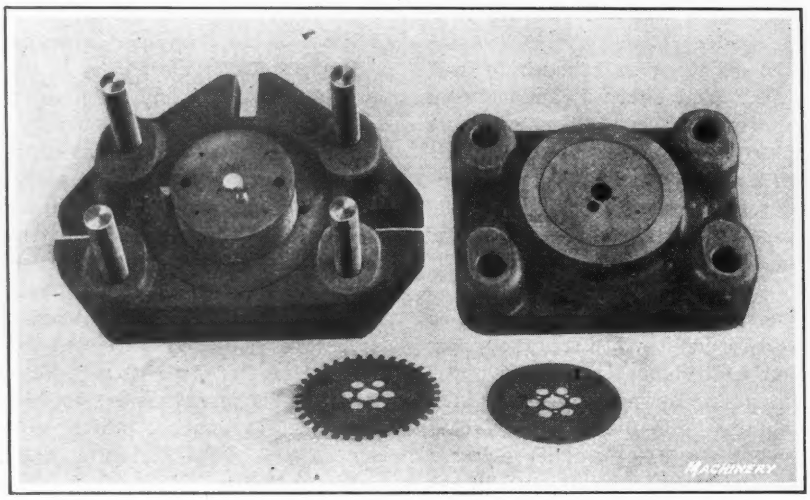


Fig. 5. Trimming and Repunching Die for Rotor Punchings

The stripper *J* is attached to the upper holder *A* in the regular way, and through it the twenty-four punches *H* held in the punch-plate operate. Attention is called to the use of two series of stripper springs rather than one, and also to the locking pin for the stripper screw nut. Die-block *C* in the lower holder *B* carries twenty-four die segments *K* which are set into the die-block and secured by four pin-keys *L*. For the purpose of indexing the die one-half space preparatory to punching the intermediate slots during the second stroke of the press ram, the handle *E* is attached to the center stud *D* beneath the lower holder, and is offset so as to operate in a recess cut in the holder, as shown. This handle carries a detent block *F* in which the spring-actuated detent *G* is carried, which engages notches in a steel plate attached to the lower casting. Attention is called to the shape of the handle at section *X–X;* it is made this shape in order to prevent congestion of the scrap stock which falls through the openings in the die. If some such means of relief were not provided, the scrap would pile up between the handle and the lower holder as the handle is brought back and forth under the openings in the holder.

The multiple slotting die illustrated in Fig. 9 is a modification of the die just described and is used in performing the same operation. It was first thought that where the die openings must be close together, a design such as was later developed would not be sufficiently strong to perform the services required of it efficiently. The results obtained with the die to be described prove, however, that this idea was a fallacy. In this design forty-eight punches *D* are carried in the punch-plate *C* instead of twenty-four, as in the other die. The stripper *E* is backed up by one set of four coil springs, instead of two sets of sixteen as in the other case, and is connected with the lower holder *B* by means of two machine-steel stripper rods, which furnish additional stability to the punches. Forty-eight die sections *G* are set into the die-block or plate *F*, and the knock-outs *H* which operate in the die openings are supported by pins which rest on three knock-out plates *J*. These knock-out plates form a ring and are set into the lower holder, each ring section being, in turn, supported on the knock-out ring *L* by means of the two supporting pins *K*.

A positive knock-out mechanism on the machine is employed to operate the knock-out ring for the purpose of ejecting the scrap material from the die openings on the upward traverse of the press ram. This knock-out mechanism (not shown in the illustration) is connected by rods to the press ram and functions with it on every ascent. In this respect

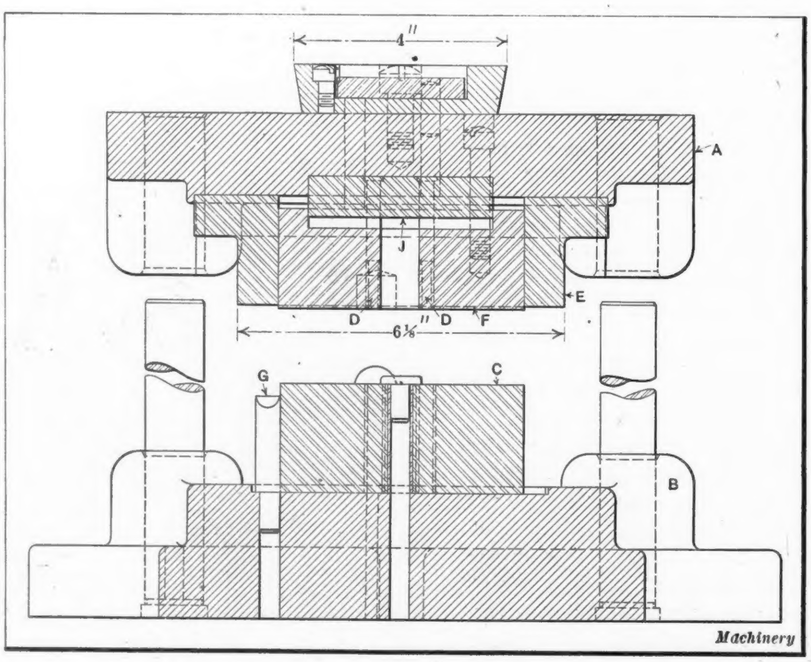


Fig. 6. Sectional View of the Sub-press illustrated in Fig. 5

it will be seen that the design is quite different from that shown in Fig. 7, and that the narrowness of the knock-out sections makes it imperative that rather slender supports be used, so that the interposition of the knock-out plates is necessary to provide a more substantial construction. The operation of this sub-press will be readily understood.

The operations required in the manufacture of these rotor stampings are performed on Ferracute inclined presses, one of which is shown in Fig. 11, set up for the slotting operation. This illustration shows the two-stroke type of sub-press described in connection with Fig. 7. The operator is using a pair of pliers to remove the work from the press. This is a safety measure which is taken by the General Electric Co., as the use of the hands to remove work from power presses is forbidden, and this rule cannot, under any conditions, be violated by the operator.

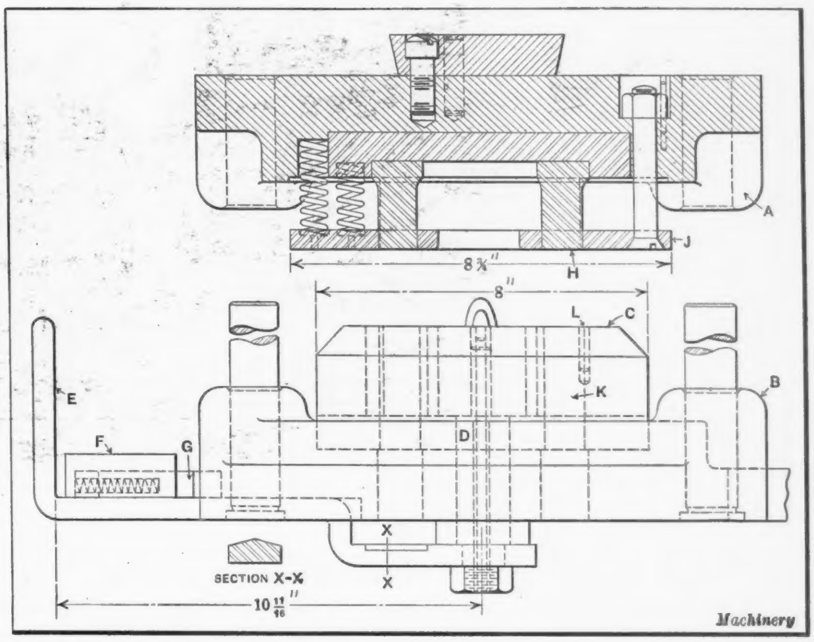


Fig. 7. Detailed View of the Two-stroke Multiple Slotting Die shown in Fig. 8

Dies for Punching Center and Air-space Holes in Rotor Stampings

Another type of the numerous armature stampings used in motor construction is shown in Fig. 10, together with the sub-press employed in the production of the work. A sectional view of this sub-press is shown in Fig. 13. The upper holder *A* carries the punch *H* and the knock-out plate shown in section in the head-block, by means of which the stripper *J* is operated. This stripper operates against three coil springs which are set into it and into the punch-plate, after the general arrangement of similar stripping mechanisms. Three air-space punches *G* are attached to the punch-plate through a hole in which punch *H* operates. This provides for advancing punch *H* ahead of the air-space punches, and enables greater concentricity of the center hole and the air spaces than would be realized if all the punches worked in unison. During a preliminary operation the work is blanked out, and it is then set on die *C* of holder *B*, on which it is located concentrically by means of three jaws *E*, the radial position of which may be adjusted in the adjusting ring *F*, to compensate for any variation in the periphery of the blank or any slight irregularity that may exist. This adjustable feature consists simply of three elongated holes in the bottom ring *D*, in which shoulder screws are used to fasten the jaws in place, and three coil springs which act radially against these screws. The construction is clearly shown in the sectional view.

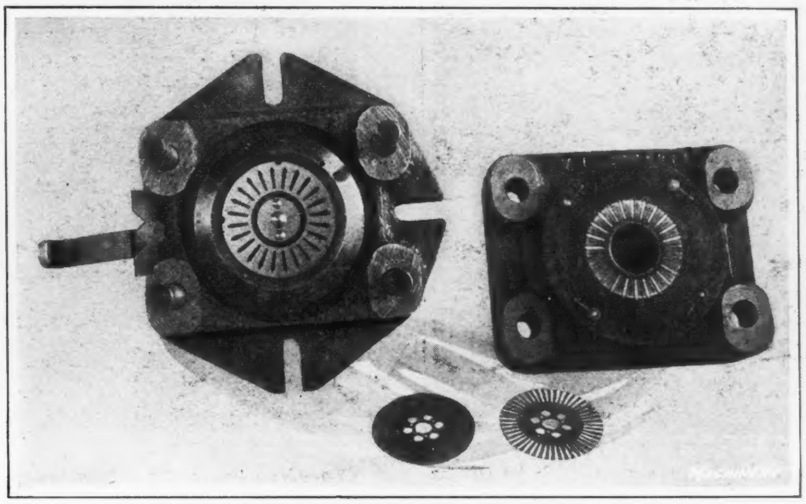


Fig. 8. Two-stroke Multiple Slotting Die with Indexing Arrangement

In operation, the stripper *J* first comes into contact with the locating jaws, after which punch *H* punches the center hole and enters a hole in the die, so that on the continued downward stroke of the press ram the blank is held in such a manner that the air spaces will be punched concentric with the center hole. The general appearance of the die and of the adjusting ring may be more clearly seen by referring to Fig. 10, and the set-up by referring to Fig. 14. This operation is performed on a Ferracute press, and the sub-press is of the two-pillar type, being different in this respect from the sub-presses described in connection with the production of sewing machine motor stampings.

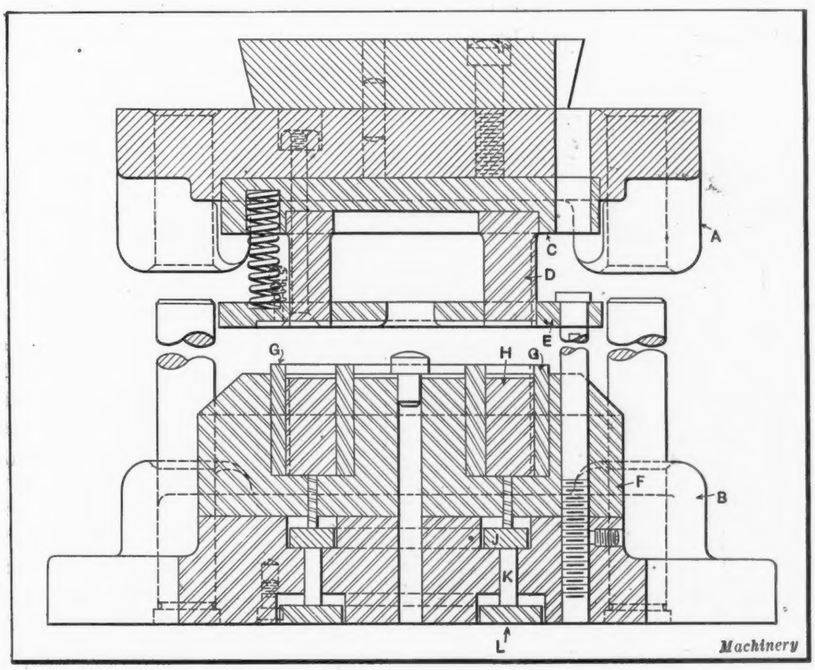


Fig. 9. Single-stroke Multiple Slotting Sub-press Die for Rotor Stampings

Example of Follow-die Design

The follow-die shown in Fig. 15 is employed in the production of brush-holder levers, one of which may be seen lying on the die-block in Fig. 12. This illustration shows a press set up for this operation. After the strip stock is fed under the die-plate, spring-stop *A* is used to locate it from the end, while two holes are pierced by punches *D* and *E*, Fig. 15. The relation of these two holes to each other is illustrated in the plan view of the die, which is shown in the lower part of the illustration. At this time punch *F* has performed no work, but on the second stroke of the press ram the stock is advanced against the left-hand stop *B*, Fig 12, so that at the same time that the finished stamping is being produced by this punch the punches *D* and *E*, Fig. 15, are operating in the follow-up position. It will be noticed that punch *F* carries a pilot which engages the large hole previously punched and insures concentricity of the surrounding stock with the hole.

Stop *B*, Fig. 12, engages the hole left in the stock after the stamping has been punched out. The operation is then simply an ordinary power press operation, in which each stroke of the press produces a complete stamping. After the strip stock has been passed entirely through the die, it is reversed and fed in from the same direction for the purpose of making use of the scrap stock remaining. While the stock is passing through the die the second time, stop *C* is used. This stop engages the narrow section of the opening produced in the scrap stock while it was previously passing through the dies.

The brush-holder levers stamped out in the follow-die described do not require to be exact duplicates. If it were necessary to meet this condition, a die of the follow type would not be suitable for the work, since it is only in the rapid production of the rougher class of stampings that the follow-die finds special application. The sub-press, which stands for the highest degree of accuracy in stamping work, represents such a large initial cost that it cannot replace the follow-die for the quantity production of work such as has just been referred to.

The present installment reviews in some detail the design and operation of various types of compound blanking and perforating dies of the sub-press type of construction, including, for the sake of completeness, a description of one follow-die. The examples presented embody all the vital mechanical features found in blanking and piercing or slotting dies commonly employed in an electric motor shop. There are, of course, a multiplicity of shapes and designs of stampings being constantly produced in the General Electric Co.'s plant, but a rehearsal of additional examples, dif-

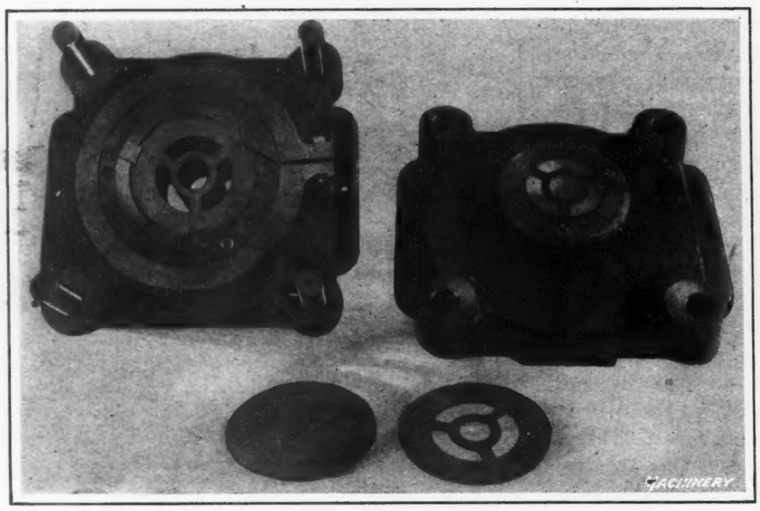


Fig. 10. Sub-press Dies and the Motor Stampings which are punched out

Fig. 11. Inclined Power Press set up with Sub-press Dies for slotting Rotor Stampings

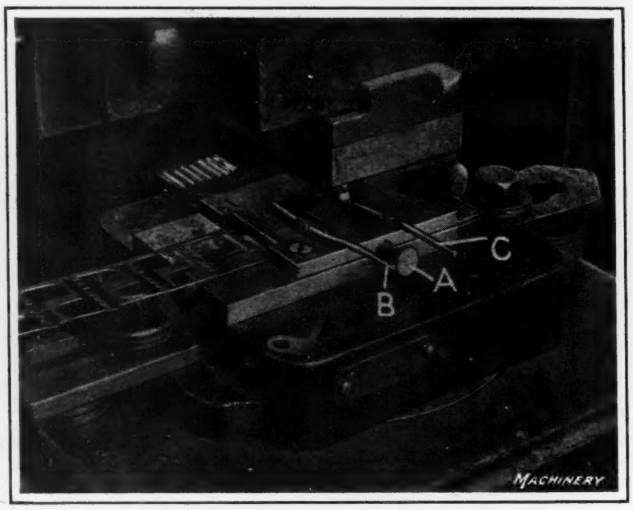


Fig. 12. Set-up of Punch Press equipped with the Dies illustrated in Fig. 15

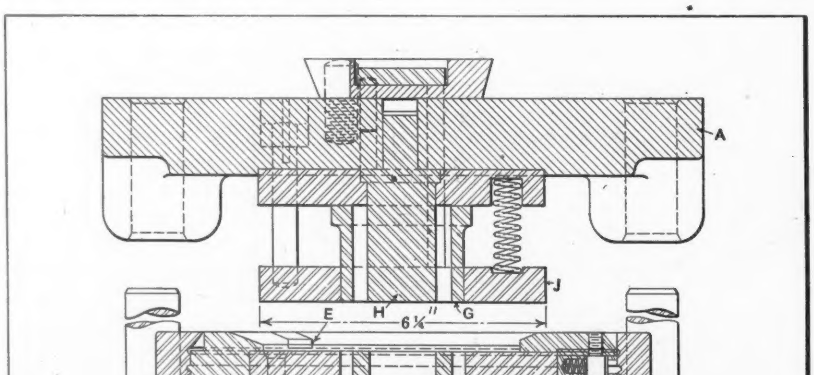


Fig. 13. Sectional View of the Center-hole and Air-space Die for producing Induction Motor Armature Stampings

Fig. 14. Inclined Press set up for punching the Center Hole and Air Spaces in Induction Motor Stampings

fering only in the contour of the work and not in the construction of the die, would serve no purpose.

The concluding installment of this article, which will be published in the December number of MACHINERY, will describe the power press equipment used in the production of street railway motor gear-cases; the two types of dies used in making turbine motor stampings; an automatic feeding mechanism and stop for power presses; and the indexing mechanism and work-holding devices used on notching presses when producing electric motor stampings.

* * *

The first steel works and rolling mill in South America has recently been placed in operation by the Argentine Iron & Steel Works, Ltd., a company started in 1912 mainly with British capital, and which, up to the present has manufactured bolts, nuts, rivets, nails and wood saws.

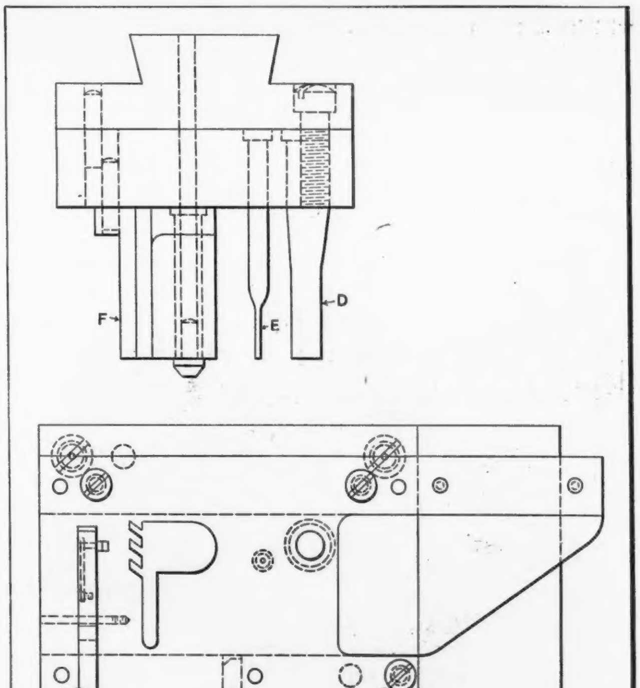
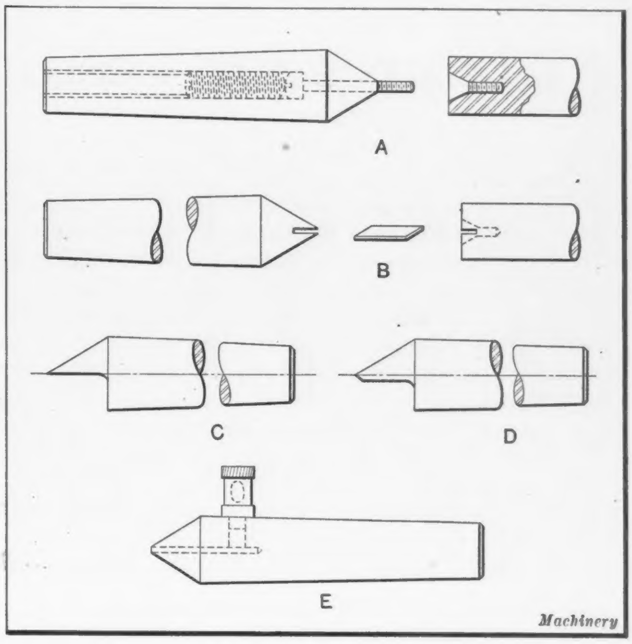


Fig. 15. Punch and Die of the Follow Type used in producing Brush-holder Levers from Strip Stock

SPECIAL LATHE CENTERS

By H. H. PARKER

The illustration shows a few types of lathe centers which frequently prove useful on occasions when ordinary centers are unsatisfactory. When desiring to turn small work having insufficient room to accommodate a dog or some other holder employed for driving purposes, or when the entire length of the piece must be machined at one setting, a screw-point live center such as shown at *A* may be of value. This center has an inserted screw with its threaded end projecting beyond the end of the center. The screw is held in place by means of a locking set-screw in the tapped hole of the center which bears upon the head of the inserted screw. In preparing the work to be used in connection with this center, the end is drilled as usual, and is then drilled in further and tapped to suit the screw, upon which it is mounted when placed in the lathe. If the point of the screw should become broken, it can be driven out and another screw substituted. In instances similar to those mentioned, a live center such as shown at *B* can also be used. It will be seen that the ends of the center and the work have a narrow slit.



Types of Centers employed for Special Purposes

A small, flat, spring-steel key is inserted in these slits to accomplish the rotation of the work. The centers described in the foregoing are, of course, only suitable to be used in supporting small work on which light cuts are being taken.

Sometimes a "half" center is used in the tailstock if it is desired to get close to the center of the work when facing the end, or when turning a piece of small diameter. Often, however, the "half" center is constructed too literally, as shown at *C*. Such a center acts much as a reamer or a cutter and destroys the center hole in the work. The proper construction for such a center is shown at *D* in which less than half of the point is cut away, thus leaving a small cone-shaped point which fits into the center hole. The result obtained by the use of this center is the same as when a very small dead center of the design ordinarily used is employed.

A dead center having an oil-hole drilled longitudinally through the point and a larger hole drilled at right angles to it into which a small oil-cup is driven, is shown at *E*. This feature permits ready lubrication of the point and reduces the likelihood of the center becoming burnt. It is somewhat difficult to harden a center of this type after the holes are drilled, but if sufficient care is taken this may be accomplished satisfactorily.

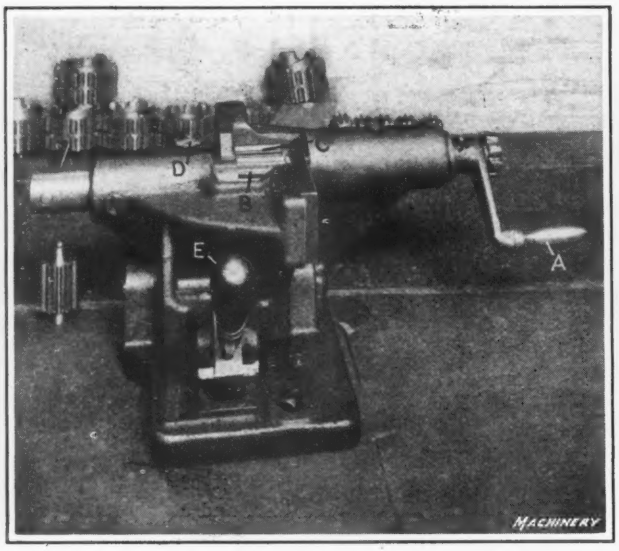


Fig. 1. Fixture for testing Concentricity of Pitch Circle, Pitch Diameter, Tooth Thickness, and Freedom from Rolling Interference in Oil-pump Pinions

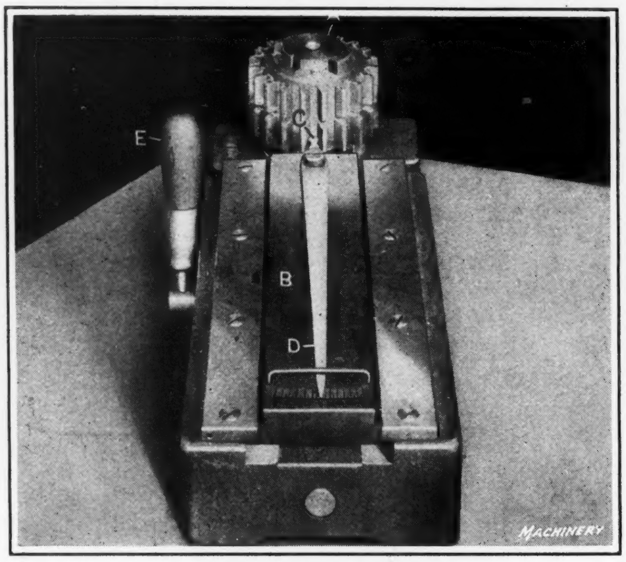


Fig. 2. Fixture for testing Relationship between Position of Keyway and Gear Teeth in Crankshaft Sprockets. Limits of Tolerance, ± 20 Minutes

Fixtures for Testing Automobile Gears

If the engine and transmission of a motor car are to run without noise, it will be apparent that the gears must be accurately cut. In some automobile plants, a great deal of study has been devoted to the development of methods for producing gears that will attain the highest degree of accuracy; but even where the utmost care is exercised in gear-cutting, it is not assumed that the product is satisfactory until each gear has been subjected to the most searching inspections to make sure that all of its dimensions are within the required limits of tolerance. For making such inspections, a number of interesting fixtures have been developed. All of these fixtures were made for testing various gears which enter into a well-known automobile; but with slight modifications of design, such fixtures could be employed with satisfactory results for testing the gears used in a great variety of products besides motor cars.

Testing Concentricity of Pitch Circle, Pitch Diameter, Tooth Thickness, and Freedom from Rolling Interference

In Fig. 1 there is shown a fixture that provides for testing the concentricity of the pitch circle with the bore, the accuracy of the pitch diameter and tooth thickness, and the freedom from rolling interference in the gear teeth. As shown in the illustration, this fixture is employed for making these tests on small oil-pump pinions, but similar fixtures are used for testing various other gears. The gear to be tested is carried on an arbor supported by a swinging bracket, the gear being in mesh with a master pinion and mounted on its arbor in such a way that it is free to rotate. In using this fixture, the turning of crank-handle *A* causes the master gear *B* to rotate and thus turns the gear *C* to be tested, which is in mesh with the master. It will be evident that if the pitch diameter and tooth thickness are uniform, and if the pitch circle is concentric with the bore of the gear and there is no rolling interference in the teeth, there will be no tendency for the bracket on which the test gear is mounted to have an oscillatory movement imparted to it. But if the gear under test is imperfect, the bracket will have to swing on its pivotal support.

Secured to the swinging bracket there is a plunger which engages the contact point of a Lowe test indicator *D*, and any inaccuracy of the gear is shown by the movement of the indicator needle. While turning crank *A* to revolve the gears, the operator holds lever *E* which provides for keeping the swinging bracket in such a position that the gears are held firmly in mesh with each other. In using this fixture

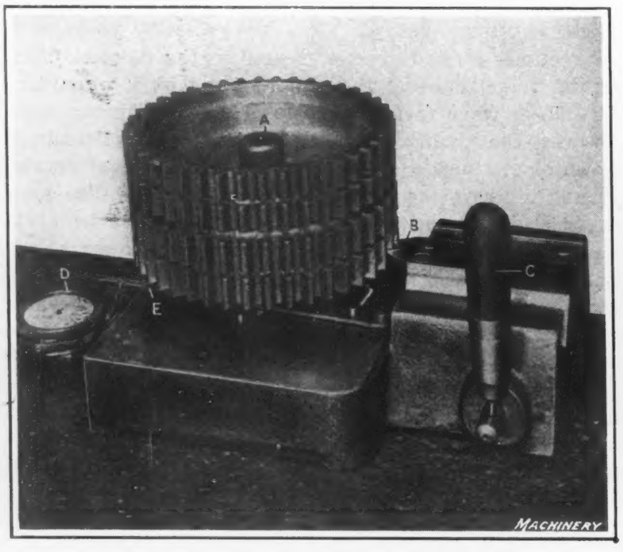


Fig. 3. Fixture for testing the Concentricity of the Pitch Circle, the Tooth Thickness, and the Pitch Diameter of Camshaft Sprockets

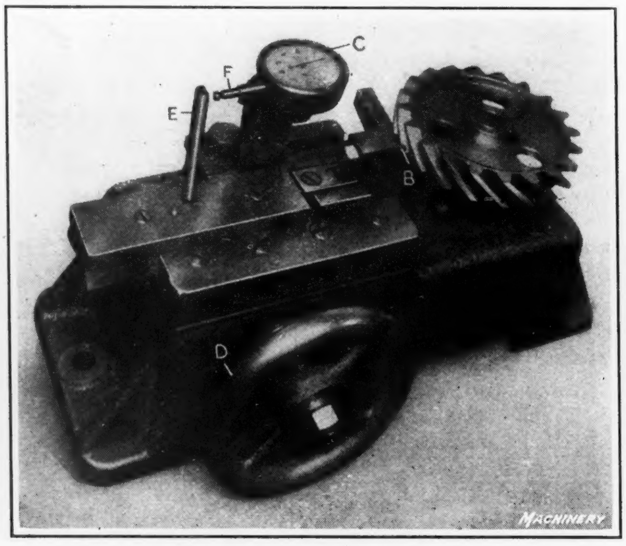


Fig. 4. Fixture used for testing Pitch Diameter, Concentricity of Pitch Circle, and Tooth Thickness of Oil-pump Shaft Spiral Gears

the master gear is not continually employed. It is used in making tests from time to time, the actual method of procedure being to use the master gear to select a "standard" gear which will run properly with it. Then this standard gear is employed for testing until there is possibility of its having been sufficiently worn to allow inaccurate gears to pass inspection. This test gear is then discarded and the master gear is employed to make another selection of a standard gear for use on the fixture. In conducting these tests, oil-pump pinions are required to have the pitch diameter and the concentricity of the pitch circle accurate within ± 0.001 inch, while the tooth thickness and freedom from rolling interference must be accurate to within 0.0005 inch. Errors of the first two kinds are shown by gradual fluctuations of the indicator needle, but if errors of either of the latter kinds are present in the gear, the needle makes abrupt movements.

Testing Relationship between Position of Keyway and Gear Teeth

In order to obtain the proper timing between the crankshaft and camshaft, it is necessary for the position of the keyway in the crankshaft sprocket to be located within limits of ± 20 minutes of arc of its proper position. For use in testing the accuracy of location of this keyway, the fixture shown in Fig. 2 is employed. It is of quite simple design, consisting of an arbor on which the gear is mounted, with a key on the arbor that enters the keyway in the gear. Mounted on the body of the fixture there is a slide *B* which has an indicator needle pivotally supported on it. The forward end *C* of this needle is shaped to fit into the space between the gear teeth, and the ratio of the arms of the needle is made sufficiently great so that the point *D* has sufficient movement to enable the graduations of the scale over which it swings to be widely spaced to facilitate easy reading.

In using this fixture, slide *B* is moved back and forth by hand-lever *E*, the method of procedure being to advance point *C* of the indicator needle between two gear teeth and then note the position of point *D* of the needle over its scale. After this has been done, the slide and its needle are withdrawn from the gear, and after turning the gear through a quarter revolution, the needle is advanced into the next tooth space which it is to occupy, and another indicator reading is then taken. This operation is repeated four times. The gears to be tested have twenty teeth and the keyway is required to be centered on a diametrical line passing through the center of the space between two teeth. Hence, if the relationship between the keyway and the gear teeth is accurate, the indicator needle will not be deflected from its central position when advanced into the space between the gear teeth. Testing the location of the keyway from four positions gives added assurance of accuracy.

Testing Pitch Diameter, Concentricity of Pitch Circle, and Tooth Thickness of Camshaft Sprockets

Fig. 3 illustrates an apparatus of quite different design from the fixture shown in Fig. 1, although it is employed for making the same general kind of tests. In the present case, the gear to be tested is a camshaft sprocket and it is required to have the concentricity of the pitch circle and the pitch diameter accurate to within 0.002 inch, while the tooth thickness must be accurate to within 0.001 inch. The method of conducting the test is quite simple. It will be seen that the gear to be tested is supported on an arbor *A* and that a contactor point *B* is arranged to straddle a gear tooth. This contactor is so designed that its points come down and engage opposite sides of a gear tooth at the pitch circle. Provision for advancing the contactor toward or withdrawing it from the gear is made by means of lever *C* that manipulates a slide on which the contactor is supported. In setting up the fixture, a master gear is mounted on arbor *A*, and contactor *B* is brought into engagement with it, after which the indicator *D* is set to zero. Then with a regular production gear set up on arbor *A*, it will be apparent that so long as the three dimensions under investigation are accurate, contactor point *B* may be brought into engagement with the gear without causing the indicator needle to be deflected from its zero position. Connection between the indicator *D* and the slide that carries contactor *B* is made by means of a bellcrank lever *E* having a ratio of 5 to 1, so that even the slightest errors in the dimensions of the gear will at once become apparent.

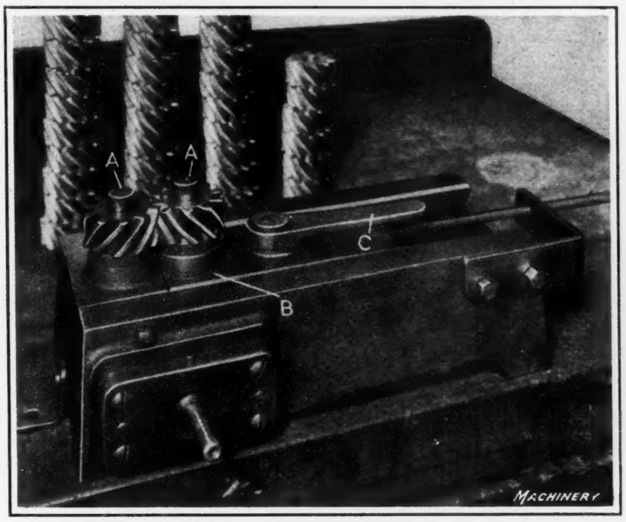


Fig. 5. Fixture for testing Running Action of Spiral Gears. Interchangeable Parallel Arbors and Adjustment of the Center Distance provide for testing Various Sizes of Gears on this Fixture

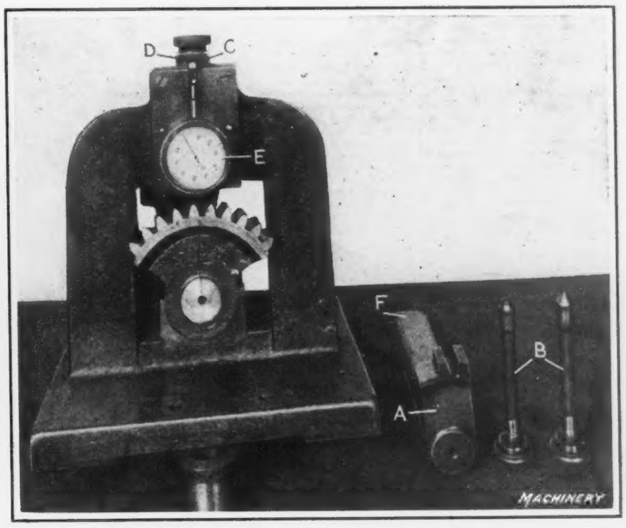


Fig. 6. Fixture used for testing Root, Pitch, and Throat Diameters of Worm-wheel Sector for Steering Gear. Three Plungers are used interchangeably for making these Measurements

Testing Pitch Diameter, Concentricity of Pitch Circle, and Tooth Thickness of Spiral Gears

Fig. 4 illustrates a fixture of quite different design from the one shown in Fig. 3, although it provides for making the same tests that are conducted on that apparatus. The present fixture is employed for testing spiral gears for assembly on oil-pump shafts. In setting up this apparatus, a standard gear is first mounted on arbor *A*, and after bringing the contactor point *B* into engagement with a gear tooth, the indicator *C* is set to read zero. Then a regular production gear is substituted, and the testing fixture is used by advancing the contactor point *B* into engagement with successive teeth as the gear is indexed one tooth space at a time. Advancing the contactor point to the work and withdrawing it to enable the gear to be indexed is accomplished by means of a handwheel *D* which traverses the slide on which contactor *B* is mounted.

It will be apparent that at the rear end of this slide there is a post *E* that engages the plunger *F* of indicator *C*. So

long as there is no error in the dimensions of the gear, this indicator needle will remain over the zero graduation, but if either the pitch diameter, the concentricity of the pitch circle, or the thickness of the gear teeth is inaccurate, it will be evident that contactor *B* will not advance inward to its normal position, and hence the indicator needle will not come to rest over the zero graduation, where it was set while the contactor point was in engagement with the tooth of a standard gear. These oil-pump shaft spiral gears are required to have the concentricity of pitch circle and the pitch diameter accurate within ± 0.001 inch, while the thickness of the gear teeth must be accurate within ± 0.0005 inch. The work-holding pilot *A* on this fixture is adjustable for holding three different gears, all of which have teeth of the same pitch so that it is unnecessary to change the contactor point *B*. If an error is detected by either of the fixtures shown in Figs. 3 and 4, the kind of error may be identified by the way in which the indicator needle is deflected.

Testing Running Action of Spiral Gears

For use in determining the smoothness with which small spiral gears are able to run, a testing fixture shown in Fig. 5 is used. It will be seen to consist of a pair of parallel arbors *A* over which two gears are dropped so that they mesh with each other. The right-hand arbor is carried by a slide *B*, the position of which may be adjusted along the bed of the fixture and clamped by means of a lever *C* that operates an eccentric binder, in order to make provision for varying the center distance to enable gears of different pitch diameters to be set up for testing. The gears shown in this illustration are spiral gears for use on the water-pump shaft, but these are only one of many types of gears that are similarly tested. The inspector places two gears in mesh on arbors *A* and then proceeds to roll them, using the palms of his hands on the outside of the gears to apply the necessary tractive force. In this way he is able to feel instantly any irregularity in the rolling action.

It has been found that an arrangement of parallel arbors of this kind affords a more sensitive test than a fixture arranged with arbors at right angles. In addition to providing for adjusting the center-to-center distance of the gears, the arbors *A* may be changed to provide for setting up gears which have bores of other diameters. Attention is called to the fact that this test is purely for the smoothness of running action and that it has no reference to any tendency of the gears to produce noise while running. For use in testing their freedom from this objectionable property, all important gears are tested on a special machine on which a gear is driven at high speed while in mesh with a master gear.

Testing the Root, Pitch, and Throat Diameters of Worm-wheels

For use in determining the accuracy of the root, pitch and throat diameters of worm-wheel sectors for steering gears, a fixture such as shown in Fig. 6 is used. As in previous outfits which have been described, the different tests are made by using a dial indicator to show any lack of accuracy that exists in the work. In setting up this fixture, a master segment *A* is employed, which is mounted under the indicator so that the latter may be set for a zero reading that corresponds with an accurate condition of the work. As it is necessary to measure the root, pitch, and throat diameters of these worm-wheel segments, it will be apparent that three tests must be employed, and there are three separate contactors, two of which are shown at *B*, that provide for reaching the different points on the work where measurements have to be made. These plungers are set up successively in a slide shown at *C*, and it will be noticed that each plunger has a knurled head and a threaded portion directly below the head, which provides for screwing the plunger into a tapped hole provided in the slide for that purpose.

Slide *C* is pushed down against a compression spring to provide for bringing the contactor into engagement with the work, and a cross-pin *D* on the slide comes into engagement with the plunger of the indicator *E*. If the worm-wheel segment under test is accurate, the slide will continue to go down until the contactor strikes the work, leaving the indicator needle standing over the zero position on the scale On the throat and root diameters the limits of tolerance are ± 0.005 inch and on the pitch diameter the limits of tolerance are ± 0.001 inch. It will be apparent that the contactors *B* are not changed for making tests on a single worm-wheel segment. Each segment has a shank, as indicated on the master at *F*, which is pushed into a bearing in the fixture. All of the root diameters are tested on a series of worm-wheel segments, then all of the pitch diameters, and finally all of the throat diameters. Such a procedure avoids the necessity of losing time in changing the contactors that come into engagement with the work at different points.

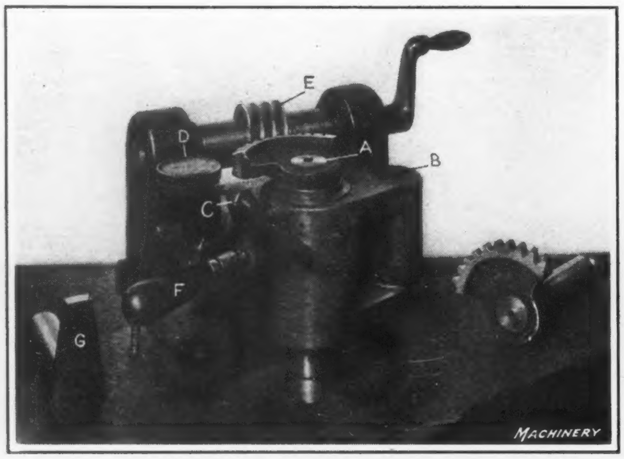


Fig. 7. Fixture for testing the Pitch Radius of Worm-wheel Sectors for Steering Gear

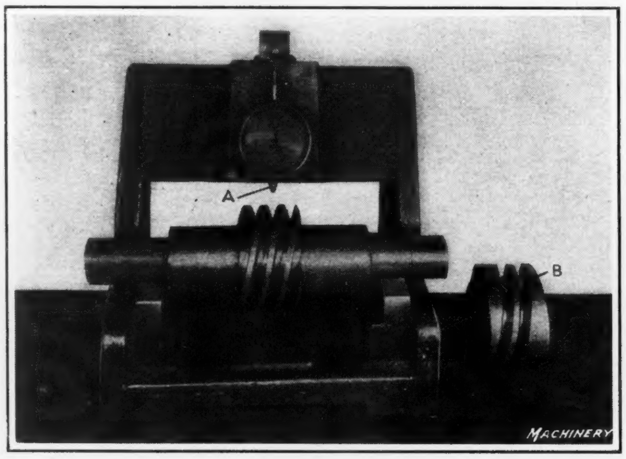


Fig. 8. Fixture used for testing the Included Angle and the Pitch Diameter of Worms

Testing Pitch Radius of Worm-wheel Sectors

Fig. 7 shows a fixture that provides for testing the pitch radius of worm-wheel sectors for steering gears. It will be apparent that the sector to be tested is mounted on an arbor *A* carried by a bracket that swings on pivot *B*. At the opposite end of this bracket from the pivot, there is an arm *C* that comes into contact with the plunger of a dial indicator *D* when the worm-wheel segment is brought into mesh with the master worm *E* by pushing over handle *F*. In setting up this fixture, a master gage *G* is used in place of the worm-wheel segment, the radius of this gage being such that when it comes into engagement with the arbor on which the worm *E* is carried, the indicator may be set to zero. In other words, the radius of the test arm *G* plus the radius of the arbor is equal to the center-to-center distance of the worm-wheel sector and the worm. It is apparent that when the worm-wheel sector and worm are brought into mesh, arm *C*

comes into contact with the plunger on dial indicator *D*, and if the pitch radius of the worm-wheel sector is accurate, the indicator needle will come to rest over the zero graduation on the dial. The pitch radius of the worm-wheel sectors is made slightly over size at the center, so that wear which occurs more rapidly at this point will not show serious results for a long period of time. Owing to this practice of making the sector slightly over size at the center, the test of the pitch radius is conducted at that point.

Testing Included Angle of Worm Threads and the Pitch Diameter

For testing the included angle of worm threads and the pitch diameter, a fixture such as shown in Fig. 8 is used. It will be seen to consist of a dial indicator provided with a plunger *A*, the form of which corresponds to that of the included angle of the thread of the worm to be tested. This plunger is made with knife-edges so that it drops into engagement with the worm thread and not only tests the pitch diameter by the indicator, but by having the fixture standing in front of a window, the form of the thread may be checked against that of the templet *A* by the familiar light test. Should it happen that the included angle of the thread is wrong, this condition will be shown by failure of the indicator point *A* to engage the thread uniformly; and any error in the pitch diameter will be made apparent by the fact that the plunger *A* does not come to rest in its normal position, and hence the indicator needle is deflected from the zero graduation on the dial. In setting up the fixture, the usual practice is followed of using a master, shown at *B*, against which the indicator is set to zero. In testing these worms it is required that the pitch diameter shall be within ± 0.001 inch of the specified size.

Advantages of Testing Gears as they are Produced

It goes without saying that in a plant where so much care is taken in testing all of the important dimensions on gears, a corresponding amount of attention will be paid to the tooling and operation of all types of gear-cutting machines. In connection with the work of the gear-cutting department, it is important to note that as rapidly as gears are cut, they are sent to the inspectors who use the various gages which have been described for checking all important dimensions.

* * *

TABLE FOR CALCULATING OUTSIDE DIAMETER OF WORMS

An article showing the derivation of a formula for checking the outside diameter of standard worm threads by the three-wire system, without the use of special wires for each thread pitch, was published in the August number of MACHINERY on page 1131. A table presented with that article gave the width of flat at the top of the thread, and a value for one of the unknown quantities in the formula, corresponding to each pitch of thread. Some of the values as tabulated were incorrect; the correct figures are given below.

TABLE USED TO MEASURE PITCH DIAMETER OF STANDARD WORM THREADS BY THREE-WIRE METHOD

No. of Threads per Inch	Pitch, P	Thickness, t	(P — t)	3.8666 (P — t)
1	1.0000	0.3350	0.6650	2.5713
1½	0.6667	0.2233	0.4434	1.7145
2	0.5000	0.1675	0.3325	1.2856
2½	0.4000	0.1340	0.2660	1.0285
3	0.3333	0.1117	0.2216	0.8568
3½	0.2857	0.0957	0.1900	0.7347
4	0.2500	0.0838	0.1662	0.6426
5	0.2000	0.0670	0.1330	0.5143
6	0.1667	0.0558	0.1109	0.4288
7	0.1429	0.0479	0.0950	0.3673
8	0.1250	0.0419	0.0831	0.3213

Machinery

SIMPLE METHOD OF MILLING DOVETAIL GROOVES

By DONALD A. HAMPSON

Machining dovetail grooves is one of the most difficult operations frequently performed in the ordinary shop. When the dimensions of the groove are small, a great amount of skill is necessary if a nice sliding or driving fit must be made with the mating piece. The grooves are usually machined with end-milling cutters having the required contour or with planing tools. These tools are often so frail that they are likely to break, thus retarding production. It is customary to relieve this condition by roughing out the groove to the shape of a square or to that of a dovetail of smaller size. Larger grooves, like those on the saddles of machine tools, are finished at higher production rates because the size of the grooves permits more rugged cutting tools with a longer life, to be used. When a gib is used to fit the parts at assembly, the grooves may be cut somewhat less accurately, because then a difference in size of several thousandths of an inch can be readily compensated for. Vertical and horizontal milling machines are most frequently used in performing the work under discussion. Shops unprovided with machines of the horizontal type perform the operation by using angular end-milling cutters and either the vertical or horizontal feeds of the machine. The presence

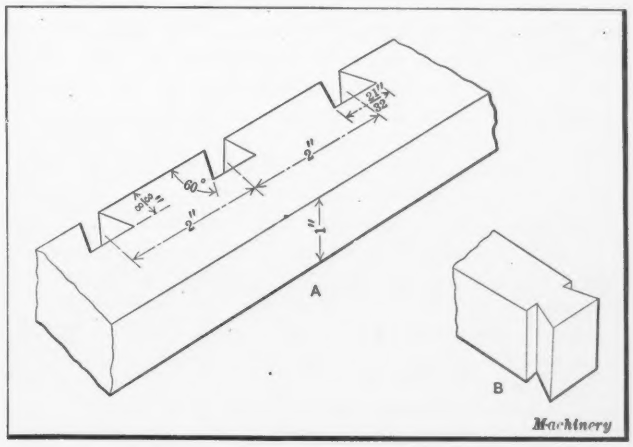


Fig. 1. (A) Section of Steel Bar provided with Three Dovetail Grooves at Center. (B) Dovetail Tongue on Ends of Bar used in tying together Two Bars of the Type shown at A

of any backlash during the operation may prove disastrous especially if the material is as tough as steel.

Original and Present Methods of Machining Dovetail Grooves in Long Steel Bars

Fig. 1 at *A* shows a section of a steel bar 80 inches in length that is used in pairs with the dovetail grooves of one bar opposite those of the other. The two bars are joined in that relation by means of a center bar provided at the ends with a dovetail tongue as shown at *B*. These tongues must fit the grooves so closely that the center bar can be pushed in and out by hand but will not fall out due to its own weight. One of the bars in each pair is 1½ inches wide, the other being 2 inches wide. The three grooves in each bar must be accurately spaced, and in some cases the central groove is required to be in the middle of the bar length within a tolerance of 0.004 inch. It was originally the custom to rough out the grooves on a shaper with an ordinary parting tool having a width 1/64 inch narrower than the mouth of the grooves, the tool being fed the full depth. If the stock of cutters was low the grooves were further roughed out by under-cutting them about 15 degrees, this operation also being performed on the shaper. However, cutters of the size required for finishing these grooves are extremely fragile, and would break regularly.

Fig. 3 shows the arrangement subsequently employed for the job which permitted the operation to be accurately and readily performed. It consists of a fixture which holds two

bars at a time on the machine table at an angle of 30 degrees with the milling cutter spindle. A long tongue on the bottom of the fixture insures accurate angular location. A special arbor is provided on which is mounted a 60-degree high-speed steel milling cutter. The vertical hand feed of the table is used to feed the work to the cutter.

The method of securing the work on the fixture will be readily understood by referring to the diagram shown at *A*, Fig. 2. Clamps *D* and *E* hold the two bars in place on the fixture, being aided by the block *F* which is necessary on account of the different bar widths. The two bars are also held together by clips which can be seen in Fig. 3. These clips are tightened after the bars have been properly set in an endwise direction.

Detailed Description of Procedure Followed in Performing the Operation

The first step preparatory to machining the grooves is to lay out carefully the center line of the middle one. Then by use of a templet and a sharp scriber, the outlines of the three grooves are marked off, these lines being later used in setting the cutters for taking the first cut. In order to set the bars accurately for machining a second groove after a cut has been finished on the first, a block 2 inches long, to suit the distance between each groove, and a slip of cigarette paper are placed tightly between a measuring boss on one of the clips and one on the fixture. Then after a cut has been taken on the first groove, clamps *D* and *E* are loosened and the bars slid along the fixture until the paper is again held tightly between the boss on the clip and that on the fixture. The clamps are then retightened and the cut taken on the second groove. The work is located by the same means for machining the third groove.

When a cut has been taken on one side of each groove, the bars are turned over so that the wide bar is uppermost, the position of the clips, however, remaining unchanged. This brings the other side of the middle groove in line with the cutting edge of the milling cutter. It is necessary to measure the location of the middle groove in order to obtain an accurate location. However, the second and third grooves are located by the use of a 2-inch block in the same manner used in locating them when taking the cuts on the opposite side of the groove.

The width of the milling cutter is as great as the mouth of the groove will permit. After the second cut has been taken in any one of the grooves, its appearance is as shown at *B*, Fig. 2, there still being metal in the bottom that cannot be removed by the cutter and which must be hogged out later in a separate operation. However, as the work must be inspected before it is removed from the milling machine, it was necessary to design a gage which would permit the grooves to be tested before the excess metal was hogged out. The measuring end of the gage used for the purpose is shown at *C*, Fig. 2. The bar is always so located

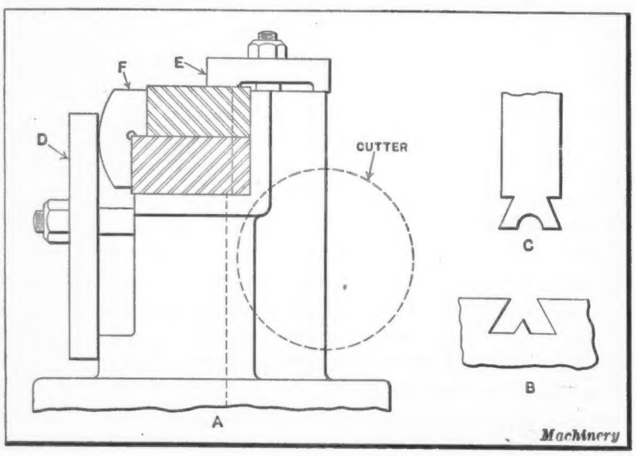


Fig. 2. (A) Diagram showing Method employed in holding Bars on Milling Fixture. (B) Appearance of Groove after Both Sides have been machined. (C) End of Gage used in inspecting the Grooves

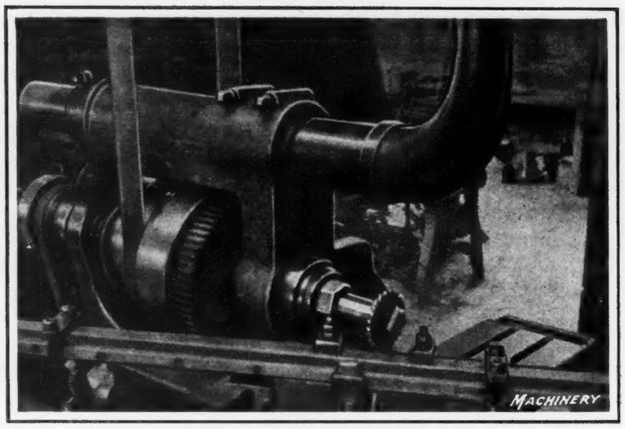


Fig. 3. View showing Set-up of Work on Machine Table, and Special Cutter and Arbor employed

for the first cut on the second side of each groove that the size will be a trifle small, the succeeding cuts being then taken until the gage can be fitted properly.

When it is required that the middle groove be in the exact center of the bar length, a slightly different order is followed. In this case the first cut is made just inside the scribed line of the middle groove. Then an extension rod with a screw stop is set to the end of the bars, the bars turned upside down with the opposite ends placed against the stop, and a cut taken on the second side of the same groove. This results in a groove in which the gage fits too tightly, but by the use of proper feelers between the stop and bars, and by turning the bars once or twice, taking a cut each time they are turned, the desired fit can be obtained with the middle groove in the exact central location. The other grooves are located with respect to the cutter by making 2-inch shifts as previously described.

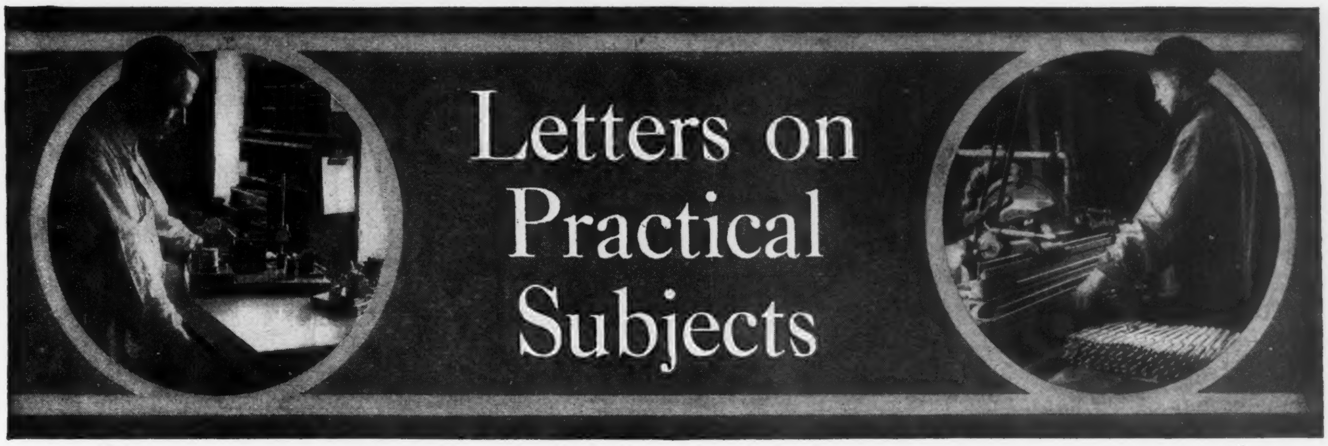
It will be noticed that in the methods described, there is no backlash harmful to the tools, and the possibility of misreading dials and misinterpreting rules is eliminated. Where it formerly took one-half day to produce three grooves of varying fits, the arrangement described finishes a set of bars in 1½ hours, including the time consumed in setting up and dismantling the work. This method overcame the necessity for a special machine and reduced tool breakage 95 per cent.

* * *

THE AUTOMOBILE INDUSTRY

The automobile business is the largest manufacturing business of finished goods in the world. This year the total volume of the automobile, accessory and supply business in this country alone will reach $4,400,000,000, of which over $2,000,000,000 will represent passenger cars and trucks. There is one car in use for approximately every 13 persons in the United States, as compared with one for every 2182 persons in the rest of the world—268 in England, 402 in France, 684 in Germany, and 5300 in Russia. Europe has 449,000,000 people and only 437,000 automobiles. It is estimated that 45 per cent of the automobiles sold in this country are bought by farmers and the inhabitants of small towns. The average life of a car is estimated at five years.

There are about 800,000 trucks in operation in the United States, hauling an average of 4½ tons per day each, which amounts to a total of 3,600,000 tons per day, or 360,000,000 tons per year. It is stated that railroad locomotives haul 2,400,000,000 tons per year. Figures show that the average ton-mile cost of motor-truck haulage is 18 cents, as against 0.96 cent by railroad locomotive; but the railroad terminal charges are large, and time is saved by the motor truck. Haulage by horse is estimated to cost 24 cents per ton-mile, and it is said that truck haulage has released 3,600,000 horses for various other purposes in the United States. The automobile accessory and supply business, including tires, gasoline and oil, has reached a volume greater than that of the automobile business itself.



FORMS FOR REPORTING INJURIES OF WORKMEN

An editorial comment on page 1030 of the July number of MACHINERY called attention to the fact that the power press is today the most dangerous machine in the metal-working trades, and cited an instance where the general superintendent of a concern was unaware of the large number of injuries occurring to his employes. Sometimes an operator is actually injured by the misuse of a safety device on the machine. The common reply to an inquiry as to the cause of an accident on a power press is that the ram descended twice; but a subsequent inspection usually shows that the operator, rather than the machine, was at fault. Disregarding the moral viewpoint, the prevention of accidents should receive the same careful attention that executives give to other details of their business, because each injury means money lost to the employer and interferes with production to some extent. One way to reduce accidents is to remind the machine operator constantly to be careful, because the more familiar a workman becomes with the machine he operates, the more careless he becomes of danger resulting from its operation.

INJURY AND INSPECTION REPORT

DEPT.- Press

NAME- R. Fieldo	INSPECTED- 6/15/20
NUMBER- 306	MACHINE NO.- 200
DATE- 6/15/20	JOB NO.- 3123
INJURY- End of index finger crushed	OPERATION- Trim sides
CAUSE- Slippery shells	SAFETY APPLIANCES- Yes
ESTIMATED DISABILITY- Four weeks.	SUGGESTIONS Make guard extend around side of die
REMARKS- Shells require wash before this oper. Job in hurry so wash was omitted	
FOREMAN- John Ricker	SAFETY ENGINEER Sam'l Wallace

Fig. 1. Report of Injury filled out by Foreman of Department and Safety Engineer

Above all, the superintendent of a plant should be kept informed of all accidents causing injuries to employes. It is not necessary that he investigate each case personally, or that it even be reported to him the moment it occurs; a monthly report of all accidents happening during the preceding month is adequate, and this report can be made by the director of the personnel department from reports furnished him by the safety engineer and foreman of the department in which it occurs. A convenient form for the use of the safety engineer and department foremen is shown in Fig. 1, suitably filled out for a supposed injury to an employe. It will be noted that this report contains all essential information regarding the accident and allows space for suggestions as to how the machine can be safeguarded to prevent a similar occurrence.

The items "injury" and "estimated disability" should not be filled in until the patient has been examined by a doctor, after which they may be added by the personnel director. From this report a requisition should be made to carry out the improvements suggested. The monthly report, prepared from the cards of this type which accumulate during a month, is illustrated in Fig. 2. From this record the superintendent can know the exact condition of affairs and give his immediate attention if a similar accident is liable to occur on account of no improvements having been made in the safety devices on the machine. The information required by various states concerning injuries can also be furnished from the card shown in Fig. 1. In conclusion, employes should be instructed to report all injuries to their foremen, no matter how insignificant they may appear, because frequently such injuries have serious results.

Rutherford, N. J. GEORGE F. KUHNE

MONTHLY INJURY REPORT — June, 1920

NAME	NO.	DEPT.	MACH.	JOB	OPERATION	INJURY	SAFETY APPLIANCE	IMPROVED	ESTIMATED DISABILITY	DATE	REMARKS
R. Fieldo	306	Press	200	3123	Trim sides	Crushed tip of finger	Yes	No	4 weeks	6/15/20	2nd in 4 months.
Flinch	125	Assembly	Bench	1000	Scraping	Gashed thumb			2 weeks	6/20/20	Work slipped in vise.
											J. R. Smithers PERSONNEL DIRECTOR

Fig. 2. Form filled out by Personnel Director Each Month and submitted to Plant Superintendent

HANDY MICROMETER ATTACHMENTS

A standard micrometer head is often useful in lathe work when making precision settings, centering work, and checking the concentricity or parallelism. Fig. 1 shows a cast-iron bracket *A* suitable for holding the head *B* in place on the tool-slide. The distance from the bottom of the bracket to the center of the head should be such as to bring the

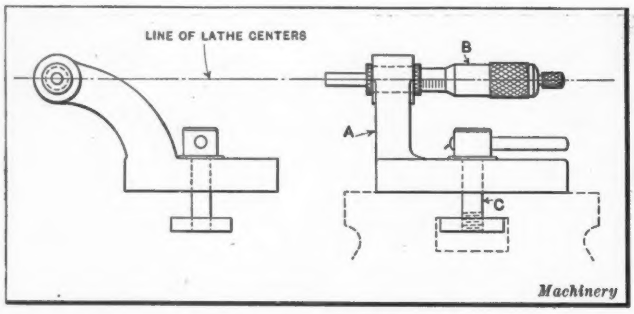


Fig. 1. Bracket for mounting Micrometer Head on Tool-slide of Lathe

center line of the latter in the same horizontal plane as that of the centers of the lathe. The base is held on the tool-slide by means of a clamping screw *C*, which is provided with a square nut contained in the T-slot on the tool-slide. Bracket *A* may be swiveled around the clamping screw, and so can be clamped parallel with the lathe bed in order to test work which has been faced; or it may be clamped at right angles to the bed for the purpose of testing the concentricity and parallelism of parts.

A bench stand for holding various sizes of micrometers at any angle from the vertical to the horizontal, and either to the right or left, to facilitate the measuring of work, is illustrated in Fig. 2. The device is simply but substantially constructed and has a neat appearance. The stand proper consists of a round cast-iron base *A*, part *B*, which may be either a piece of steel tubing or iron pipe, and cap *C* which is pressed into the top of part *B*. The cap is drilled to suit a long stud that is screwed in the base and in bracket *D* and thus holds the parts together. Bracket *D* is provided with a knurled thumb-screw that secures the swiveling block *E* to it, a small toolmaker's clamp *F* being fastened to block *E* by screws, for the purpose of holding the micrometer. A *C*-clamp drilled to suit the pivot screw in bracket *D* could also be used for this purpose. The pivot screw holds the clamp in position at any angle suitable for the convenient reading of the graduations on the micrometer. The entire stand should be machined smooth and polished, the knurling on cap *C* being chiefly for appearances.

When calipering work with a micrometer in places where the light is poor, it is often difficult to read the scale. Sometimes the design of the work also prevents the reading of the graduations. In Fig. 3 at *A* is shown an auxiliary dial attachment for micrometers which magnifies the thousandth of an inch readings and has the scale at right angles to the spindle. This, in the cases cited, is frequently a more convenient position for reading the graduations than the ordinary one. Provision is only made for reading thousandths of an inch, which is sufficient for work such as reducing the diameter slightly, or in checking repetition work. It will be seen that a spring steel clamp *D*, which is shown in detail at *B*, fits over the micrometer frame. A lug on this clamp is drilled to suit rod *E* which supports dial *F*. Another spring clamp *G* fits over the thimble of the micrometer and has a steel pointer *H* riveted to it. Rod *E* should slide stiffly in clamp *D*, but it should be possible to push it in or out as the thimble is rotated, in order to bring the face of the dial up against the pointer. As the pointer clamp is held on the thimble by friction, it may be rotated to any position relative to the thimble graduations, and held there. The dial is made of sheet steel, and after being calibrated the graduations were engraved and the numbers stamped on it. While the dial illustrated is a sector of a circle, an entire circular dial could be used. If the work is only to be checked

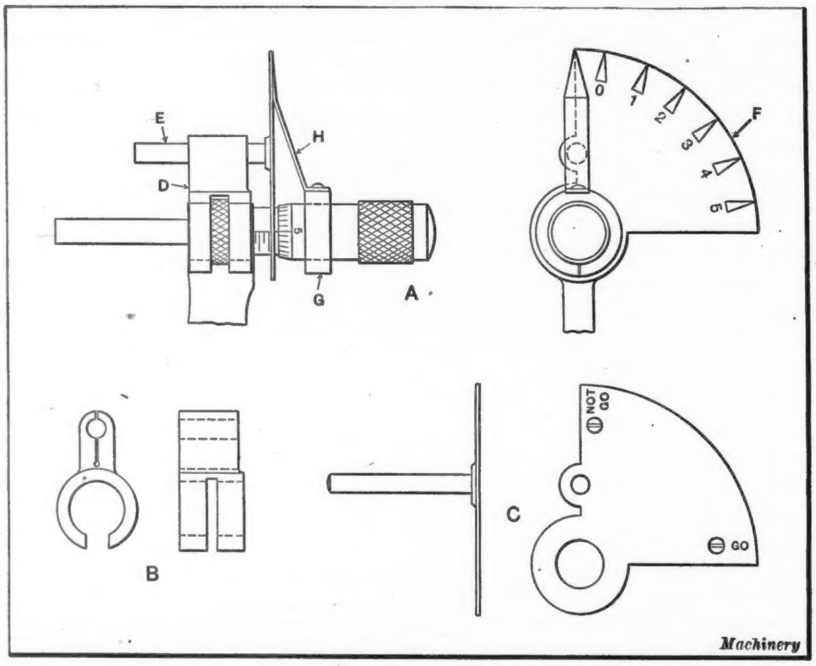


Fig. 3. Attachment which permits the Reading of Thousandths of an Inch on a Dial at Right Angles to the Spindle

to determine whether it is between limits, lugs or small screws may be provided on the dial to serve as limit stops. A sector provided with screw limit stops is shown at *C*.

Oakland, Cal. H. H. PARKER

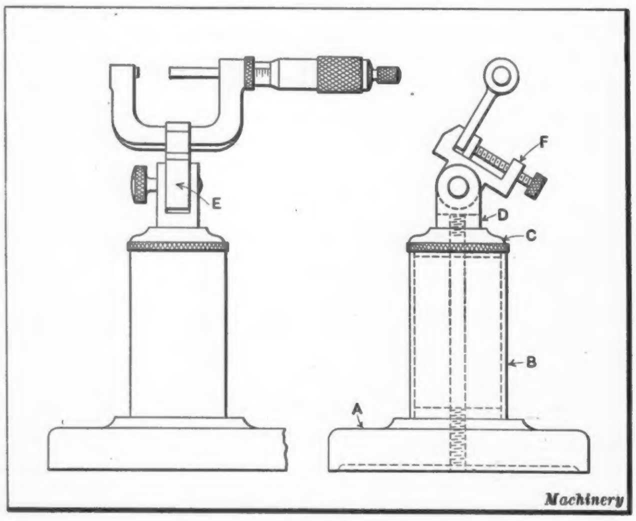


Fig. 2. Bench Stand for holding Micrometer in Angular Positions to facilitate the Measuring of Work

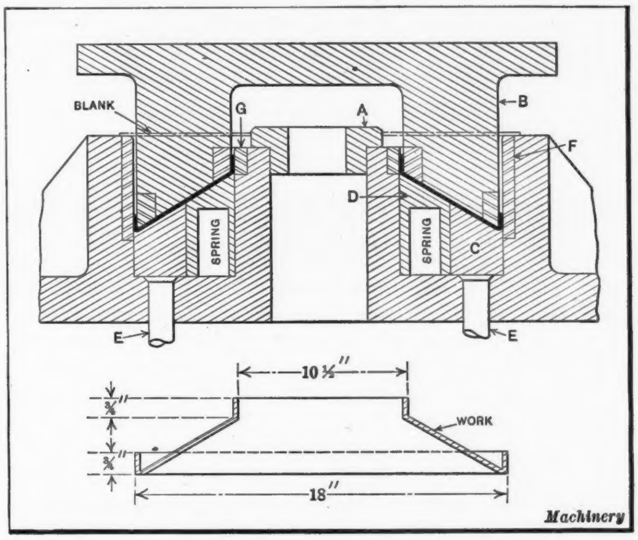
DIE FOR DRAWING FLANGED CONICAL RINGS

The punch and die used for drawing the flanged conical rings which form the sides of a certain type of blower fan are shown in the illustration. An idea of the size and shape of the rings may be obtained by referring to the drawing shown beneath the die; the material from which these rings are made is 0.065 inch thick. Two operations are required before the blank is ready for the drawing operation; the first is performed on a plain blanking die which shears the blank to the correct outside diameter. In the second operation, a hole is cut in the center of the blank, the diameter of this hole being the same as the diameter of plug *A* on the die. This permits the blank to be placed on the die as indicated by the dot-and-dash lines, and insures its proper location.

It will be noted that the illustration shows the relative positions of punch *B* and the movable parts of the die, at the time that the shaping of the work is completed. Prior to an operation, the punch is, of course, in position above

the die, and rings C and D are also in a raised position. Ring C is raised by pins E which are actuated by a rubber buffer, while ring D is raised by means of compression coil springs. The blank is then placed on the die as previously mentioned, and is forced into the die as the punch descends, the flange on the outside of the ring being formed from the metal that extends past the punch when the latter first comes in contact with the blank. This flange is held between the punch and die ring F as the punch continues to descend and, as the inner flange is similarly held, the remainder of the blank is forced to the desired shape. Ring C exerts pressure against the work during part of the downward stroke and so assists in preventing the outside flange from being drawn between the tapered surfaces of the punch and the die ring C.

The work is ejected from the die on the upward stroke of the punch by rings C and D as they are raised in the manner previously described. All the working surfaces of the punch and die are made from tool steel, and are hardened and ground. The outer circumference of the drawing ring F is ground to a taper of ½ degree, the surface of the hole, however, being ground straight. This ring is a press fit in the die-block, and after it is forced into place, the inside



Construction of Punch and Die for drawing Blower Fan Part

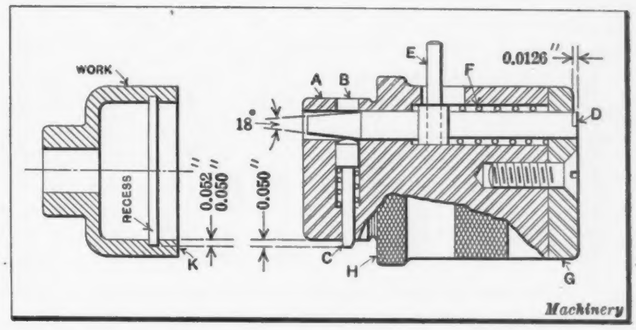
surface is again ground to size. Ring G is also a press fit on the die-block, while the two inserted rings on the punch are a similar fit on that member. The performance of this punch and die has been entirely satisfactory.

Toledo, Ohio — J. BINGHAM

FLUSH-PIN DEPTH GAGE FOR INTERNAL GROOVES

The flush-pin gage shown in the accompanying illustration was designed by the writer for the purpose of testing the depth of an internal groove or recess in parts produced in large quantities. The depth of the groove in this instance was required to be held within close limits of accuracy, as indicated in the illustration. As the gage proved a very satisfactory means of testing the work, it is believed that a description of its construction will be of value to others having similar gaging problems.

The body of the gage, which is made of machine steel, is pack-hardened and has an end A ground to fit the hole in the part to be gaged. The counterbored hole B carries a plunger C provided with a gaging point which is brought directly over the recess when end K of the work is pushed over plug A and into contact with shoulder H. The top of the gaging plunger C works against the tapered end of a registering plunger D, which fits in a



Flush-pin Gage for gaging Depth of Internal Recess

hole at right angles to hole B. Both plungers are backed up with springs as shown, so that contact is maintained at all times between the rounded end of C and the tapered end of D. When in its normal position, the point of plunger C extends beyond the surface of plug A an amount slightly greater than the greatest allowable depth of the recess to be gaged, and is normally maintained in this position by the action of spring F. A pin E, fitted in plunger D, projects through an elongated slot in the gage body and permits the registering plunger to be pulled back so that the spring actuating plunger C will push the gaging point back a sufficient amount to allow the work to be slipped on or off the gage.

Plate G is hardened and has a step ground on it which indicates whether the work is within the required limits. This plate is secured to the body of the gage by a screw and dowel-pins. The step is 0.0126 inch high and indicates a difference of 0.002 inch in the depth of the recess as the relative movements of the two plungers are in a ratio of about 6.3 to 1. Therefore if the end of the plunger D is moved from a position in which it is flush with the lower step, to a position in which it is flush with the higher step, the end of gaging plunger C will have moved 0.002 inch. By comparing the dimensions of the work and of the gage it will be seen that the recess being gaged is within the required limits of accuracy when the indicating end of plug D lies between the two steps. The 18-degree angle determines the ratio between the movements of C and D, and while it is not necessary to use this angle, it is generally advisable to use an angle not less than 18 degrees. A smaller angle would require too great a movement of the registering plunger when taking off or putting on a piece of work, unless the depth of groove to be gaged were very small.

Bridgeport, Conn. — GUSTAVE F. BAHR

MOLDING A SPECIAL I-SHAPED CASTING

In constructing a pattern, the patternmaker always predetermines the manner in which a mold is to be made. Nevertheless, it frequently happens that when the pattern is received at the foundry it is seen that the molding operation would be much simpler if carried out in a different way from that intended by the patternmaker. Slight modifications are then sometimes made in the design of the pattern to permit the molding operation to be performed as desired by the molder. When a patternmaker has access to the foundry, valuable knowledge can be obtained by observing molding

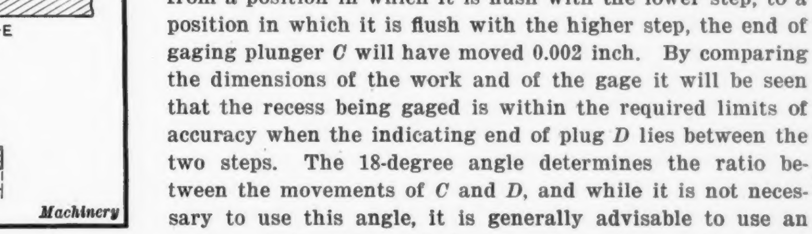


Fig. 1. Drawing of Pattern provided for molding an I-shaped Casting having Five Cored Holes

methods; however, when this is impossible much information can be had by examining castings after they are delivered to the machine shop.

Fig. 1 shows a drawing of the pattern for a special I-shaped casting having a web continuing around the ends and requiring five equally spaced ¾-inch diameter cored holes. The pattern was split along the center, the patternmaker thinking that one half should be molded in the drag and the other half in the cope. This method is considered good practice, but on account of the flimsy construction the sections were badly warped when received by the molder. This warping was corrected by nailing the two parts together, which, of course, prevented the molding of the casting as previously intended, so the mold was made entirely in the drag with the parting line along the top of the pattern. The core-prints for the five holes projected 1½ inches beyond the pattern, and so it was necessary to provide means of withdrawing the pattern from the mold in such a way that the walls of the mold would not be destroyed by these core-prints.

For this purpose two "ram-up" cores, such as indicated by the heavy dot-and-dash lines *A*, were provided for each core. The ram-up cores were cut from slab cores of the same thickness as the distance that the core-prints project beyond the pattern, and extended to the center of the pattern, the lower ends being sawed out and filed to fit the core-prints and cores. When the pattern was placed in the drag for ramming, the ram-up cores were placed in position on the core-prints. After the pattern had been rammed, the cope was lifted, the ram-up cores were withdrawn, and the pattern was extracted from the drag without having the mold marred by the core-prints. The hole cores were next placed in position, the ram-up cores put on the ends of these cores, and the cope again mounted on the drag.

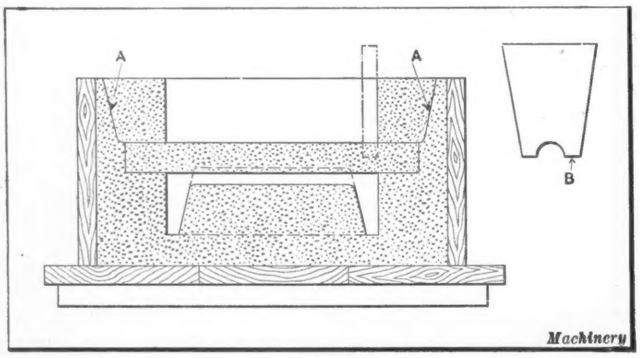


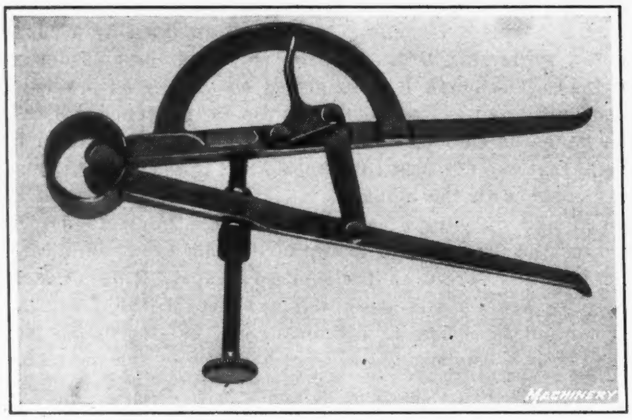
Fig. 2. Method in which Casting could have been molded in the Drag without Special Ram-up Cores

Another way in which a mold could have been made in the drag without the use of ram-up cores is illustrated in Fig. 2. The pattern is placed in the drag and the sand of the drag and cope is rammed. Then, after the cope is lifted, pockets are dug in the drag as indicated by lines *A* to permit the core-prints to be raised with the pattern. After the cores have been placed in position, these pockets are again filled in and rammed, a small board about ½ inch thick, sawed to the shape shown at *B* being placed on each core as the corresponding pocket is being rammed, in order to permit the wall to be formed properly.

Kenosha, Wis. M. E. DUGGAN

INSIDE CALIPER WITH GRADUATED SCALE

The illustration shows a pair of inside calipers provided with an attachment consisting of a graduated scale and an indicator which points to the graduation on the scale corresponding to the distance across the measuring points of the legs. This eliminates the necessity of using a measuring scale or a micrometer in setting this caliper or in examining it from time to time to ascertain whether the setting has been changed. A glance at the position of the indicator is sufficient to find out whether the setting has become altered in laying the caliper down or in having it come in contact with some object. The scale is graduated to indicate the dimensions of holes ranging from ⅜ to 2⅝ inches in diameter. An important advantage derived from the attachment is the determination of the diameter of a recess or groove in a hole. This is impossible with an ordinary caliper, because the setting of the measuring point must be changed before the caliper can be withdrawn from the recess for measurement.



Inside Caliper provided with Graduated Scale and Indicator for showing the Setting

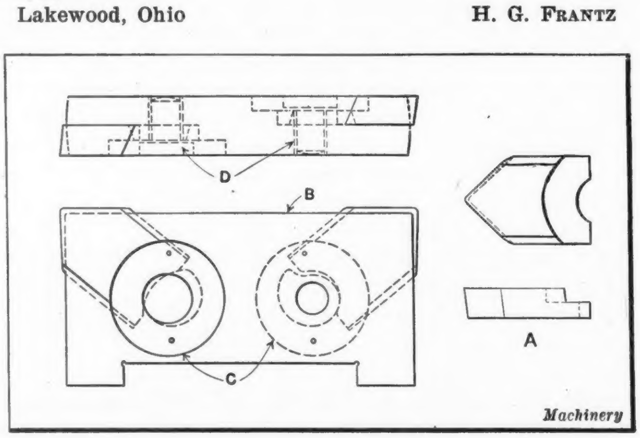
Beverly, Mass. PETER J. LINNAHAN

DUPLEX INSERTED-BLADE BORING-BAR CUTTER

The accompanying illustration shows a boring-bar cutter having two inserted blades, the cutting positions of which can be adjusted by means of cams. This feature makes possible the use of the cutter on holes of various diameters, or permits frequent regrindings without the tool becoming too small, when the cutter is constantly used for boring holes of one size. A detail of the cutter blade is shown at *A*, from which it will be seen that a circular step is milled on the rear end. The sides of each cutter are ground to an angle of 15 degrees to suit the slots in holder *B*.

Cam parts *C* have large circular portions which fit into holes counterbored in holder *B* and rest on the steps of the blades. The cam on each of parts *C* is on the inner side, the ends of the cams resting against the bottom of the slots in which the cutter blades are contained. The cam surfaces bear against the rear ends of the cutter blades so that the positions of the latter are altered when the cam parts are turned by means of a pin wrench inserted in the small holes in their outer surfaces. The parts *C* are tightened down on the blades by means of screws *D*, the heads of which enter counterbored holes in parts *C*. It will be noted that the blades are placed in the holder on opposite sides as well as at opposite ends.

Lakewood, Ohio H. G. FRANTZ



Boring-bar Cutter having Blades which can be adjusted by Cams

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

DISK AND V-BLOCK METHOD OF DETERMINING THE RADIUS OF A CIRCULAR SEGMENT

A. R. N.—In the August number of MACHINERY, page 1176, a method of determining the radius of a disk was explained. A 90-degree V-block, a depth micrometer, and a standard disk are used, and the object is to find the radius of a smaller disk. The writer assumes that this method is intended more especially for obtaining the radii of circular segments between 90 and 180 degrees, in view of the fact that the radius of any segment larger than 180 degrees or the radius of a complete disk would be determined ordinarily by first measuring the diameter, the V-block and disk method not being necessary. One or more examples illustrating the practical application of this method would be appreciated.

ANSWERED BY GEORGE WARMINGTON, BEVERLY, MASS.[1]

The V-block method is particularly applicable for finding the radius of a circular segment, as for example the radius r of the part shown at A, Fig. 1. If the radius R (see diagram B, Fig. 1) of the standard disk equals 1.25 inches, and the dimension H is found by measurement to equal 0.256 inch, then applying the previously published formula $r = R - H$ (2.4142), we have

$$r = 1.25 - 0.256\ (2.4142) = 0.632 \text{ inch}$$

The writer considers the following derivation of this formula for radius r simpler than the derivation given in the August number of MACHINERY.

Referring to diagram B, Fig. 1,

$$\text{Cos 45 degrees} = \frac{R-y}{R+H}$$

$$y = R - (R + H) \cos 45 \text{ degrees} \qquad (1)$$

and

$$\text{Cos 45 degrees} = \frac{r-y}{r}$$

$$y = r - r \cos 45 \text{ degrees} \qquad (2)$$

Then, from Equations (1) and (2),

$$r - r \cos 45 \text{ deg.} = R - (R + H) \cos 45 \text{ deg.}$$

$$r = R - \frac{H \cos 45 \text{ deg.}}{1 - \cos 45 \text{ deg.}} = R - H\ (2.4142)$$

As the 90-degree V-block cannot be used for arcs less than 90 degrees, the so-called "bridge-iron" method will be explained. The required equipment consists of two disks or plugs each having the same radius r (see Fig. 2); a parallel which is placed in contact with the disks; and a plate in which there is an elongated slot, which permits the disks to be clamped in different positions. The radius r is known, and the dimensions A and H are obtained by measurement.

[1]Another derivation which is also simpler than the one previously published was submitted by Gustaf E. Nordstrom, Worcester, Mass.—Editor

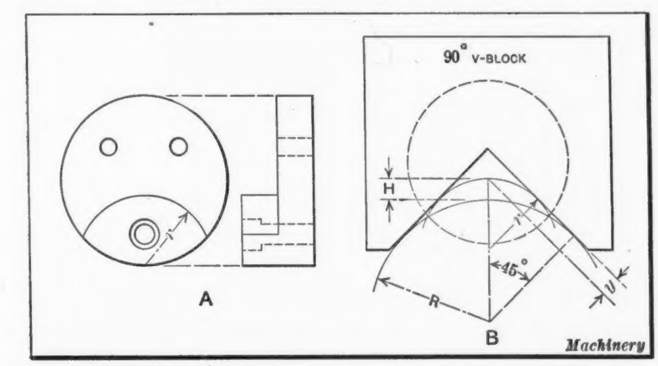


Fig. 1. Part having Circular Segment, and Method of determining its Radius by using V-block and Disk

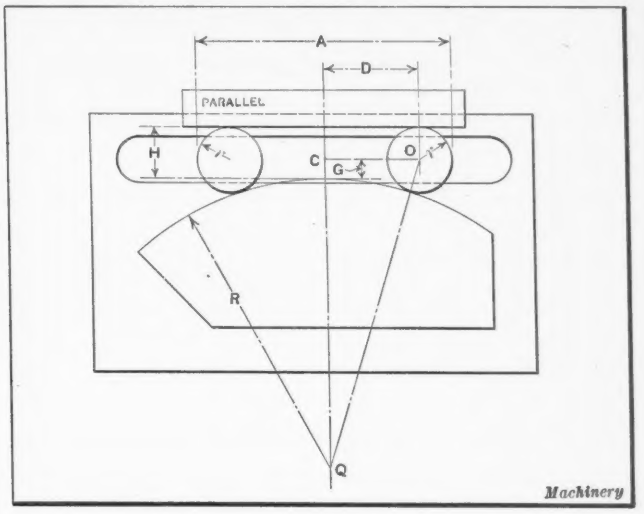


Fig. 2. Another Device for determining Radii of Segments

$$D = \frac{A - 2r}{2} \qquad G = H - r$$

In the triangle QCO,

$$(R + r)^2 = (R + G)^2 + D^2$$

$$R^2 + 2Rr + r^2 = R^2 + 2RG + G^2 + D^2$$

Cancelling R^2 from each side of the equation and transposing,

$$2Rr - 2RG = G^2 + D^2 - r^2$$

$$R = \frac{G^2 + D^2 - r^2}{2\,(r - G)}$$

If the segment-shaped section of the part shown at A, Fig. 1, were less than 90 degrees, the radius could be readily determined by the bridge-iron method, which can be applied to various classes of work, although the exact arrangement may require more or less modification. For example, if a radius of a slot were to be determined, it might be necessary to use plugs or pins small enough to enter the slot. Care should be taken to see that the value of G in the formula for radius R, is equal to the vertical distance between the center lines of the plugs or disks and the top of the arc which is in contact with the plugs. For instance, when determining the radius of a curved slot, G should equal the distance from the center line of the plugs to the top of that side of the slot which is in contact with the plugs.

PROBLEM IN TRIGONOMETRY

L. M. S.—Will you please show how to find the angles A and B from the angle and dimensions given in the accompanying illustration?

A.—From trigonometry we have the relations:

$$r^2 = b^2 + c^2 - 2bc \cos B \qquad (1)$$

$$r^2 = a^2 + c^2 - 2ac \cos A \qquad (2)$$

Subtracting (2) from (1)

$$b^2 - a^2 - 2bc \cos B + 2ac \cos A = 0 \qquad (3)$$

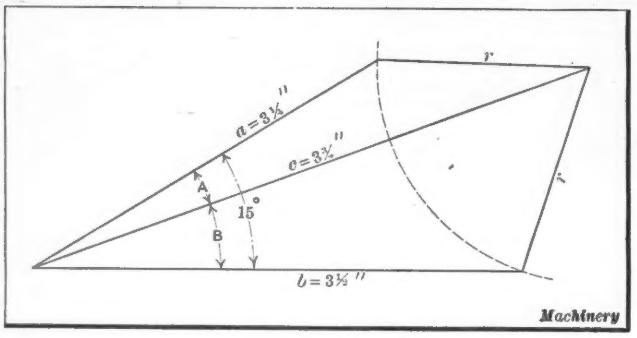
$$A = 15 \text{ degrees} - B$$

Cos A = cos (15 deg. — B) = cos 15 deg. × cos B + sin 15 deg. × sin B

Substituting this value for cos A in (3)

$b^2 - a^2 - 2bc \cos B + 2ac$ (cos 15 deg. × cos B + sin 15 deg. × sin B) = 0

Expanding, combining, and arranging terms,



Problem in Trigonometry

$2c\ (a \cos 15 \text{ deg.} - b) \cos B + 2ac \sin 15 \text{ deg.} \sin B = a^2 - b^2$ (4)

This is an equation of the form

$$m \cos B + n \sin B = q \qquad (A)$$

in which

$m = 2c\ (a \cos 15 \text{ degrees} - b)$

$n = 2ac \sin 15 \text{ degrees}$

$q = a^2 - b^2 = (a + b)\ (a - b)$

Solving this equation by the methods of trigonometry

$$\tan x = \frac{m}{n} \qquad (B)$$

$$\text{Sin}\ (x + B) = \frac{q \sin x}{m} \qquad (C)$$

Inserting numerical values in (4) we find m, n, and q.

From (B)

$$x = 156 \text{ degrees } 47 \text{ minutes}$$

Then from (C)

$$(x + B) = 165 \text{ degrees } 46 \text{ minutes}$$

$B = 165$ deg. 46 min. — 156 deg. 47 min. = 8 deg. 59 min.

$A = 15$ deg. — $B = 15$ deg. — 8 deg. 59 min. = 6 deg. 1 min.

W. W. J.

SAFE SPEED OF FLYWHEEL

A. L. G.—A flywheel 21 feet in diameter makes 100 revolutions per minute. The weight of a cubic foot of the material is 448 pounds. If the safe stress permissible in the material is 6000 pounds per square inch, what is the greatest speed at which the wheel can be run with safety? What is the intensity of stress on a transverse section of the rim when running at 100 revolutions per minute?

A.—Assuming that the stress on the rim is unaffected by the arms, then the unit stress in the flywheel rim due to centrifugal force is found as follows: In the general equation of force, $F = ma$, the acceleration a in the present instance is $\frac{v^2}{r}$, in which v = velocity of rim in feet per second, R = radius of rim in feet, W = weight of rim in pounds, and g = acceleration due to gravity. Hence, centrifugal force $= F = \frac{Mv^2}{R} = \frac{Wv^2}{gR}$.

The resultant of half of this force tends to disrupt one half of the rim from the other half. This rupture is resisted by the two sections of the rim at each end of the diameter.

The total tension T in a cross-section of the rim is to one-half the sum of half of the radial forces as the diameter of the flywheel is to half its circumference.

Therefore

$$T = \frac{F}{2\pi} = \frac{Wv^2}{2\pi Rg}$$

Let $W = \frac{2\pi RAw}{144}$, in which A = area of cross-section of rim in square inches, and w = weight of rim material in pounds per cubic foot.

$$T = \frac{Awv^2}{144g}$$

Let $T = AS$, where S = stress per unit area of cross-section of rim.

$$S = \frac{wv^2}{144g}$$

(S is independent of the radius and depends only on the rim velocity.)

Let $v = \frac{\pi Dn}{60}$, in which D = mean diameter of rim in feet, and n = number of revolutions per minute.

$$S = \frac{w(\pi Dn)^2}{60^2 \times 144g} \qquad (1)$$

Solving for n,

$$n = \frac{720}{\pi D}\sqrt{\frac{Sg}{w}} \qquad (2)$$

Letting $D = 21$, $n = 100$, $w = 448$, $S = 6000$, and $g = 32.16$ and substituting these values in Formulas (1) and (2) $S = 1170$ pounds per square inch stress on a transverse section of the rim when running at 100 revolutions per minute, and $n = 226$ revolutions per minute, the greatest speed at which the wheel can be safely run without exceeding a fiber stress of 6000 pounds per square inch in the material.

W. W. J.

DIEMAKER'S PROBLEM

L. M. S.—The illustration shows a problem in connection with the designing of dies for blanking a sheet-metal piece. Please show how to find the radius x.

A.—Referring to the illustration, we have

$$(x + 3/16)^2 = (1/4 - x)^2 + (x + 3/32)^2$$

Then,

$$\left(\frac{16x + 3}{16}\right)^2 = \left(\frac{1 - 4x}{4}\right)^2 + \left(\frac{32x + 3}{32}\right)^2$$

Expanding, clearing of fractions, and combining,

$$1024x^2 - 704x + 37 = 0$$

This may be written

$$1024x^2 - 2(352)x + 37 = 0$$

Solving this quadratic equation,

$$x = \frac{352 \pm \sqrt{352^2 - 1024 \times 37}}{1024} = \frac{352 \pm 64\sqrt{21}}{1024}$$

$$x = \frac{11 \pm 2\sqrt{21}}{32}$$

Taking the minus sign before the radical, in this case, we find $x = \frac{11}{32} - \frac{\sqrt{21}}{16} = 0.34375 - 0.28641 = 0.05734$ inch.

W. W. J.

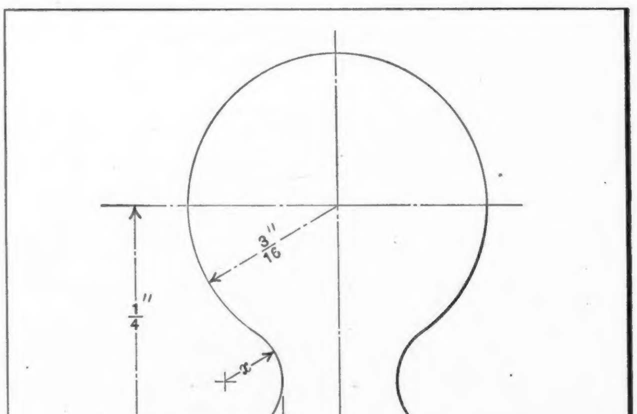


Diagram illustrating Diemaker's Problem

MEASURING SCREW THREADS BY THREE-WIRE METHOD

G. H. D.—Will you kindly show me how to deduct a formula for finding the pitch diameter of a screw by the three-wire method?

ANSWERED BY V. E. AYRE, RICHMOND COLLEGE, VA.

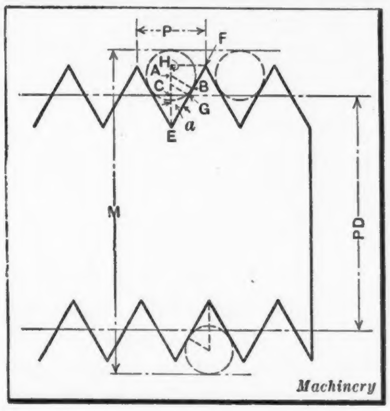


Diagram for Use in finding Pitch Diameter by Three-wire Method

The use of three wires of equal diameters for measuring the pitch diameter of screws has long been employed. The outside diameter should not be considered as a factor in any pitch diameter formula, and is not used in the following deduction, in connection with which reference should be made to the diagram, where the following notation is used:

M = micrometer reading over wires;
D = diameter of wires;
d = radius of wires;
a = one-half angle of thread;
PD = pitch diameter of screw;
P = pitch of thread.

In the triangle EHF,

$$HF = \frac{P}{2};\ EF = \frac{HF}{\sin a} = \frac{P}{2 \sin a}$$

Then

$$EG = \frac{EF}{2} = \frac{P}{4 \sin a}$$

In the triangle ABE,

$$AB = d = \text{radius of wire};\ AE = \frac{AB}{\sin a} = \frac{d}{\sin a}$$

In the triangle CGE,

$$CE = EG \cos a;\ EG = \frac{P}{4 \sin a}$$

Therefore

$$CE = \frac{P}{4 \sin a} \times \cos a = \frac{P}{4} \cot a$$

$$AC = AE - CE$$

Substituting the values of AE and CE in the above equation,

$$AC = \frac{d}{\sin a} - \frac{P}{4} \cot a$$

$$PD = M - 2d - 2AC$$

$$= M - D - 2\left(\frac{d}{\sin a} - \frac{P}{4} \cot a\right)$$

$$= M + \frac{P}{2} \cot a - D\left(1 + \frac{1}{\sin a}\right)$$

If the above equation is written

$$PD = M + \left[\frac{P}{2} \cot a - D\left(1 + \frac{1}{\sin a}\right)\right]$$

that part of the equation which is enclosed in brackets is a constant factor having a negative value and may be expressed by the letter K, so that the formula then becomes

$$PD = M + (-K)$$

or

$$PD = M - K$$

A table of values for the constant K may be made for threads of various angles and pitches. If possible, the "best size" wires, that is, wires which will be tangent to the sides of the thread at the pitch line, should be used. The diameter D of the "best size" wire may be determined as follows:

$$d = \tan a \times EG$$

But

$$EG = \frac{P}{4 \sin a}$$

Consequently

$$d = \tan a \times \frac{P}{4 \sin a}$$

and

$$D = \tan a \times \frac{P}{2 \sin a}$$

or

$$D = \frac{P}{2} \sec a$$

Example—Find the pitch diameter of a screw, having eight threads per inch, the included angle between the threads being 60 degrees.

$$\frac{P}{2} = 0.0625 \text{ inch}$$

$$a = \frac{60}{2} = 30 \text{ degrees}$$

$$D = \frac{P}{2} \sec 30 \text{ deg.} = 0.0721 \text{ inch}$$

The constant K, then has the following value:

$$K = 0.0625 \times 1.7321 - 0.0721 \times 3.0000$$

or

$$K = -0.10805 \text{ inch}$$

This value added to the measurement M taken over the wires will give the pitch diameter, that is

$$M - 0.10805 \text{ inch} = PD$$

DIFFERENCE BETWEEN A HELIX AND A SPIRAL

B. H.—What is the difference between a helix and a spiral?

A.—The curve followed by a screw thread is a helix, whereas an ordinary watch spring is an example of a spiral curve, although it may not be a perfect spiral. A helix is the curve traced by a point which rotates uniformly over a cylindrical surface and advances at a uniform rate along the axis. A spiral is located in one plane and has a constantly increasing radius of curvature. The word spiral is often incorrectly applied in mechanical work. What are known as "spiral gears" are really helical gears, because the teeth follow helical curves. A right-hand helix advances in a clockwise direction and a left-hand helix, counter-clockwise or to the left as viewed from the end or in line with the axis.

KIND OF STEEL FOR THREAD-CUTTING DIES

W. B. B.—Should thread-cutting dies be made of carbon or high-speed steel?

A.—Carbon steel dies or die chasers are usually preferred for cutting very accurate smooth threads, as they retain a fine cutting edge better than chasers made of high-speed steel. The latter, however, may be operated at considerably higher cutting speeds, and the quality of the work is satisfactory for a great many classes of work. The difference of opinion regarding the relative merits of carbon steel and high-speed steel for dies are doubtless due in part to variations in the composition of the steels used and to the different methods of heat-treatment.

* * *

French foreign trade figures for the period January 1 to July 31, 1920, show an increase of 2,738,502,000 francs in imports and 7,230,220,000 francs in exports over the same period of 1919.

Die-castings[1]

By CHARLES PACK, Doehler Die-Casting Co., Brooklyn, N. Y.

DIE-CASTINGS may be defined as castings made by forcing molten metal, under pressure, into a metallic mold or die. It is erroneous to assume that all die-castings have similar properties, since it is apparent that the properties of die-castings will depend upon the nature of the alloy used. The die-casting process is best adapted to alloys of comparative low fusing points which, for convenience, may be divided into the following groups:

1. Zinc alloys, consisting essentially of zinc alloyed with tin, copper, or aluminum.
2. Tin alloys, consisting essentially of tin alloyed with copper, lead, or antimony.
3. Lead alloys, consisting essentially of lead alloyed with tin or antimony.
4. Aluminum alloys, consisting essentially of aluminum alloyed with copper.

Composition and Properties of Zinc Alloys

A typical zinc alloy suitable for die-casting consists of 87.5 per cent zinc, 8 per cent tin, 4 per cent copper, and 0.5 per cent aluminum. The properties of this alloy are as follows:

Color	Silver white
Weight per cubic inch	0.253 pound
Melting point	780 degrees F.
Initial fusing point	275 degrees F.
Tensile strength	16,100 pounds per square inch
Elongation	2 per cent
Compressive strength	27,670 pounds
Hardness number (Brinell)	64.6

The weight of the die-castings made from this alloy is generally not more than 8 pounds. The minimum limit of the wall thickness varies from 0.1 inch for larger castings to 1/16 inch for smaller castings. The variations in dimensions per inch of diameter or length may be held to 0.001 inch. Twenty-four threads per inch is about the finest pitch that can be cast on external threads, while the number of threads per inch that can be cast on internal threads depends on the conditions in each case. The minimum diameter of cast holes is 1/32 inch, but this depends largely upon the shape and thickness of the casting. The draft necessary for cores is 0.001 inch per inch of length or diameter, and for side walls 0.001 inch per inch of length. The sections of the castings should be as uniform as possible. Sharp corners should be avoided and fillets should be added wherever permissible. Under-cuts in casting should be avoided wherever possible.

Alloys of this type are corroded by any alkaline or aqueous solution of salts. The castings may be polished to a high luster, but soon tarnish when exposed to ordinary atmospheric conditions. Castings made from this alloy may be readily plated with nickel, copper, brass, silver or gold. When they are properly plated, such castings will retain their luster as well as those that are made from either brass or bronze.

Castings made from this alloy should not be used for parts that are subjected to severe stress or sudden shock in service. They are used extensively for parts of phonographs, calculating machines, drinking cups, vending machines, magneto housings, automobile-body trimmings, pencil-sharpening machines, time-recording devices, stamp-affixing machines, and for a great many other devices that are of a kindred nature.

[1]Abstract of a paper presented before the American Society of Mechanical Engineers.

Composition and Properties of Tin Alloys

The following table gives five typical tin alloys generally used for die-castings:

	Tin, Per Cent	Copper, Per Cent	Lead, Per Cent	Antimony, Per Cent
1	90	4.5	0	5.5
2	86	6	0	8
3	84	7	0	9
4	80	0	10	10
5	61.5	3	25	10.5

Alloy No. 1 is a so-called "genuine babbitt" metal, and was used very extensively during the war for main-shaft and connecting-rod bearings on all American-made airplanes and motor trucks. No. 2 is somewhat harder, and is used extensively for bearings of internal-combustion engines. No. 3 is somewhat harder than alloy No. 2, and is the S. A. E. standard for high-grade internal-combustion-engine bearings. No. 4 is in general use for light bearings on stationary motors. No. 5 is a bearing metal for light duty, and is used on a large number of moderate-priced automobiles for main-shaft and connecting-rod bearings.

In addition to the five compositions mentioned, hundreds of similar alloys may be made, having various specific properties. The die-casting process is applicable to any of the alloys of this group, and it may be left with the engineer to specify the alloy best suited to his requirements.

The maximum fusing point of tin alloys is about 450 degrees F.; the maximum weight for castings made from these alloys, about 10 pounds; the limit in wall thickness, 1/32 inch; the variations from the given dimensions per inch of diameter or length, 0.0005 inch; and the finest pitch of thread that can be cast externally, 27 threads per inch, while the number of internal threads depends upon various conditions. The minimum diameter of hole that can be cast is 1/32 inch, but this diameter depends on the depth of the hole and the type of the casting. The required draft for cores is 0.0005 inch per inch of length or diameter, and for side walls, 0.001 inch per inch of length.

Tin alloys find their largest field of application in their use as bearings for internal-combustion engines. They are also used for parts of soda fountains, cream separators, milking machines, surgical apparatus, galvanometer parts, player pianos, etc., where a tensile strength of over 8000 pounds per square inch is not essential and where resistance to corrosion is of importance. They are not affected by water, weak acid or alkaline solutions, and when free from lead, are extensively used for food-container parts.

Composition and Properties of Lead Alloys for Die-castings

The following table gives the composition of typical alloys in the lead-alloy group which are used for die-castings:

	Lead, Per Cent	Tin, Per Cent	Antimony, Per Cent
1	83	0	17
2	90	0	10
3	80	10	10
4	80	5	15

Alloy No. 1 is generally known as C. T. (coffin trimming) metal, due to its extensive use in the manufacture of coffin trimmings. This alloy is also a good bearing metal for light duty, and is used for thrust washers and camshaft bearings on light internal-combustion engines. No. 2 is somewhat softer and more ductile than No. 1. No. 3 is used extensively for light bearing duty, being somewhat tougher and stronger than Nos. 1 and 2. No. 4 is somewhat harder than No. 3, but less ductile.

The maximum fusing point of alloys of this type is about 600 degrees F.; the maximum weight for castings made from lead alloys, 15 pounds; the maximum wall thickness, 1/32 inch; the variation from the given dimensions per inch of diameter or length, 0.001 inch; the finest number of threads that can be cast externally, 24 per inch; the number of threads cast internally depends upon various conditions. The minimum diameter of cast holes is 1/32 inch, depending, however, on the depth and general design of the casting. The draft for cores is 0.0005 inch per inch of length and diameter, and for side walls, 0.001 inch per inch of length.

Lead alloys may be used where a metal of non-corrosive properties is desired and where a tensile strength of not over 8000 pounds per square inch will suffice. They are used extensively for fire-extinguisher parts, low-pressure bearings, ornamental metalware, and many parts that come in contact with corrosive chemicals. They should not be used for parts that may come in contact with foods or that may be handled often in service, on account of the poisonous properties of lead and lead alloys. The main advantage of these alloys lies in their comparatively low cost, but their high specific gravity must be considered, some lead alloys having a specific gravity double that of the zinc alloys.

During the war, lead alloys were used for all hand-grenade fuse parts and many millions of these parts were made. Lead-alloy die-castings were also used for grenades, trench-mortar fuse plugs and many other parts where non-corrosiveness is an essential requirement.

Composition and Properties of Aluminum Alloys

A typical aluminum alloy for die-casting is composed of 92 per cent aluminum and 8 per cent copper. The properties of this alloy are as follows:

Color	Silver white
Weight per cubic inch	0.115 pound
Melting point	1150 degrees F.
Tensile strength	21,000 pounds per square inch
Elongation	1.5 per cent
Hardness number (Brinell)	60.5

The maximum weight of castings made from aluminum alloys is about 5 pounds, with a minimum wall thickness of 1/16 inch and a variation from the given dimensions of 0.0025 inch per inch of diameter or length. The finest thread that can be successfully cast is 20 threads per inch externally; internal threads are rarely cast. Frequently, the external threads are cast 0.010 inch over size and are finished to size by a cutting tool. The maximum diameter of cast holes is about 3/32 inch and these holes cannot be made deeper than 1 inch. Larger holes may be cast much deeper, and smaller holes may be spotted to facilitate drilling. The draft of cores should be 0.015 inch per inch of diameter or length, and the draft of side walls 0.005 inch. Cores less than ¼ inch in diameter do not need more than 0.005 inch draft per inch of length.

The aluminum alloy used for die-casting is well known in the trade as No. 12 alloy and it is used extensively for automobile and airplane parts. By varying the copper content, harder or softer alloys may be obtained, all of which may be die-cast successfully.

Aluminum die-castings find wide employment in the manufacture of parts of automobiles, such as spark and throttle control sets, magneto parts, battery ignition and lighting systems, speedometers, etc. They are also used for parts of vacuum sweepers, phonographs, milking machines, vending machines, etc.

Brass and Bronze Die-castings

Die-castings made from various types of brasses and bronzes were put on the market as early as 1910, but have never been successful commercially. At the present time there is only one die-casting manufacturer producing brass die-castings in any appreciable quantity. It is a comparatively simple matter to produce a small quantity of simple brass die-castings, but no material has yet been found for die-making purposes which will withstand the continuous action of molten brass and at the same time retain its shape, surface, and size. The die-casting of brass and bronze must be considered as in the experimental stage at the present time, with little or no immediate prospect of the solution of the problem.

Developments Due to the War

The most important development in the art of die-casting during the war was the perfection of the process of die-casting aluminum and its alloys. A suitable steel was developed for making the dies for this process that would withstand the action of molten aluminum without cracking, a problem the solution of which was essential to the development of the industry. The part that this development played in the winning of the war will be readily appreciated when it is stated that at the cessation of hostilities there were being produced about one million aluminum die-castings daily in this country for parts of gas masks, machine guns, airplanes, motor trucks, motor ambulances, surgical instruments, canteens, field binoculars, etc.

Comparative Cost of Die-castings

The cost of die-castings cannot be computed on the pound basis, since it depends on the design of the piece, the number and position of the cores, the quantity to be produced, and certain other factors. For comparative purposes it may be stated that at the present time tin-alloy castings are the highest in cost, being followed by those of aluminum alloy, zinc alloy, and lead alloy in the order named.

In considering the use of die-castings it is well to bear in mind that on a pound basis die-castings are far more expensive than iron sand castings, if the machining cost is not considered. As the zinc alloys, whose properties are similar to cast iron, cost from $200 to $275 per ton in ingot form, it is apparent that the substitution of a die-casting for an iron casting can only be considered when the machining cost is sufficient to compensate for the difference in cost of the raw materials.

* * *

NEW YORK SECTION OF AMERICAN WELDING SOCIETY

A meeting to consider the organization of a New York or Metropolitan Section of the American Welding Society was held Thursday, October 14, 1920, in the Engineering Societies Building, 29 W. 39th St., New York City. The meeting was called to order by F. W. Tupper, chairman of the Sections Organization Committee. Mr. Tupper stated that in view of the fact that active sections had already been organized in Philadelphia, Chicago and Pittsburg, it was now time that a New York Section be organized. He then called upon Professor C. A. Adams, past president of the American Welding Society, to give an account of the aims and history of the society and of its sections. W. E. Symons, treasurer, was then called upon to explain the need for a New York Section. Professor Adams was chosen as chairman of the meeting and Howard Odiorne as secretary. On motion by Roy Wanser, seconded by A. E. Glassman, it was unanimously voted that a New York or Metropolitan Section should be organized. On authorization of the meeting, the chairman appointed a nominating committee to present a slate of officers and directors for the section, to be voted on at the next meeting. At the request of the meeting the chairman also appointed a rules committee and instructed them to prepare constitution and by-laws for the New York Section for consideration at the next meeting. Membership and organization committees were then appointed, and the date of October 25 was fixed upon as the time for the official organization of the New York section to be consummated.

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The world's production of coal during 1919 was 15 per cent less than the production in 1913, and, in fact, even 10,000,000 tons less than the production in 1910.

A NEW BOOK ON MECHANICAL DRAWING

MECHANICAL DRAWING. By Franklin D. Jones. 342 pages, 6 by 9 inches; 175 illustrations. Published by THE INDUSTRIAL PRESS, 140-148 Lafayette St., New York City. Price, $3.

This book is a treatise on the drawing of mechanisms and machine details, and covers comprehensively the making of different classes of drawings; the dimensioning, reading, and checking of working drawings; numbering and filing systems for drawings, and general drafting-room practice. Numerous text-books have been published on mechanical drafting practice, but many of these are purely books for classroom use and overlook the important side of the use of mechanical drawing in industry. This book is, therefore, added to the list of publications on this subject, because it is believed that there is a need for a treatise dealing more thoroughly with methods that are actually employed in well-managed drafting-rooms.

Many books on mechanical drawing have covered such subjects as geometrical drawing problems, orthographic projection, the development of intersecting surfaces, etc., but the application of these principles and the real object of mechanical drawing as related to machine and tool manufacture has often been dealt with vaguely. The student has been taught certain details, but he has not been given a clear conception of the work of draftsmen and designers in the drafting-rooms of machine-building plants. This book presents the subject in a way that will enable the student to understand what the term "mechanical drawing" really means in its broadest sense, the essential features of modern drafting practice, and the difference between the mere representation of a design by a suitable drawing and the more valuable work of originating and developing the design.

A special effort has been made to secure a well-balanced treatise in which the various elements of mechanical drawing are dealt with according to their relative importance. For instance, little space is given to lettering, because making fancy letters in numerous styles is not the work of a draftsman in a well-managed drafting-room, although this subject has been greatly emphasized in many books. The aim has been to present methods that are in actual use rather than exercises in drawing which do not conform to the practice in manufacturing plants. An elaborate drawing of a bevel gear with all of the teeth accurately reproduced may be an attractive and impressive feature in a text-book on mechanical drawing, but it is misleading, because working drawings are not made in that way.

This book, in its arrangement and scope, is based on the assumption that it is essential for the student of mechanical drawing—whether in the school or in the shop—to understand the purpose of drawings as applied to machine and tool construction, how various mechanical devices may be represented by means of drawings, the necessity of making drawings that completely and clearly show what they are supposed to show, and the relation between *drawing* and *designing*. Special attention has been given to the dimensioning of drawings, and the importance of using printed instructions to make a drawing entirely clear is emphasized.

In dealing with the numerous details of the draftsman's work, an effort has been made to present methods that are sanctioned by common usage and to explain the reasons for the more important variations in practice. To accomplish this, the methods and systems of many of the representative drafting-rooms were studied, and much valuable information was also secured from articles pertaining to different features of drafting practice published in MACHINERY.

The comprehensive scope of the work will be understood from the chapter headings: Drawings and their Use in Machine and Tool Construction; Projection as Applied to Mechanical Drawing; Mechanical Drawing Instruments and Materials; How Designs are Originated and Procedure in Making Drawings; Sectional Views and the Reading of Drawings; Methods of Dimensioning Working Drawings; Instructions on Working Drawings and Procedure when Checking; Printing Processes and Apparatus for Printing, Washing and Drying; Engineering Standards and Drawings of Machine Details; Designing or Laying Out Cams; Geometrical Drawing Problems and the Development of Intersecting Surfaces; Drafting-room Systems, Equipment and Arrangement; and Sketching and Perspective Drawing.

* * *

WELL-KNOWN MACHINE TOOL MANUFACTURERS RESIGN

Two of the best known machine tool builders in the country—Charles E. Hildreth and Albert E. Newton—recently resigned from the management of the Whitcomb-Blaisdell Machine Tool Co. and the Reed-Prentice Co. which they respectively headed, and it is reported that they intend to associate themselves with business enterprises outside of Worcester. Mr. Newton, as is well known, is president of the National Machine Tool Builders' Association and of the National Metal Trades Association, and Mr. Hildreth is general manager of the former association.

Both the first named companies, as well as the Becker Milling Machine Co., have been controlled by the same interests, and according to a statement given out by Arthur H. Reed, president of the Reed-Prentice Co. and the Becker Milling Machine Co., changes were decided on last spring for the purpose of effecting economies and adding to the efficiency of the operating management of the three plants. A central selling office was established at 53 Franklin St., Boston, and the product of all three companies was sold direct, under the charge of John P. Ilsley, formerly general manager of the Becker Milling Machine Co. Branch sales offices have been established in the principal cities of this country and a foreign sales agent employed for Europe. F. O. Hoagland, lately vice-president and general manager of the Bilton Machine Co., Bridgeport, Conn., has become general manager of the Becker Milling Machine Co., the Whitcomb-Blaisdell Machine Tool Co., and the Reed-Prentice Co.

It was stated that both Mr. Newton and Mr. Hildreth offered their resignations some time ago, but at the request of the management agreed to continue at least until January 1, next.

* * *

ENGINEER APPOINTED ON POSTAL ADVISORY COMMITTEE

Mortimer E. Cooley of the University of Michigan, and past-president of the American Society of Mechanical Engineers, has been appointed a member of the Postal Advisory Committee which is assisting the joint Senate and House Post Office Committee in their investigation of the postal system. It will be necessary for the Advisory Committee to deal with the construction of mail tunnels, tubes, and other mail transportation and handling devices. It is gratifying to realize that the Government is becoming alive to the importance of selecting engineers to fill important positions allied with or involving engineering problems.

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AERONAUTIC SECTION OF THE A. S. M. E.

Considerable cooperative engineering work has been done in the field of aviation, standards have been established, details of construction perfected, and interchangeability secured. Nevertheless, there still exists an opportunity to promote the broad engineering development of aerial navigation, and with this in view, the American Society of Mechanical Engineers has organized an aeronautic section. A number of men who were prominent in the aeronautic field during the war have registered in this section.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

Davis Duplex Continuous Milling Machine

The keen competition in the manufacture of automobiles demands that the parts be machined as cheaply as possible without impairing the required accuracy. The duplex continuous milling machine built by the Davis & Thompson Co. was designed for milling to length automobile camshafts, crankshafts, transmission shafts, etc., at such high rates of production that the cost of this operation is materially reduced. The automatic clamping apparatus used for some kinds of work is an unusual feature, which simplifies the operation and accelerates production.

A CONTINUOUS milling machine for milling to length forgings such as automobile camshafts, crankshafts, worm and transmission shafts, and axles, or small castings used on tractors and automobiles, sad irons, etc., has been placed on the market by the Davis & Thompson Co., of 251 Reed St., Milwaukee, Wis. This machine is known as the No. 1 continuous duplex four-spindle milling machine. A full view of the machine is presented in Fig. 1, which shows its main features.

It will be noted from this illustration that there is a horizontal bed on which two housings are mounted. Each of these housings contains two cutter-spindles, one spindle being provided for rough-facing the work as the latter is rotated past it, and the other for finish-facing it. The mandrel which supports the fixture on which the work is held has a bearing in the upper portion of each spindle head, and is driven through a large bronze worm-wheel at its left end, which engages with a hardened steel worm. This worm, in turn, is driven by a motor on the top of the machine, through a single-pulley drive and gearing, including change-gears. By means of the change-gears, which are placed at the back of the machine, the number of revolutions per minute of the work-holding mandrel can be varied to suit any desired feed of the work past the cutters.

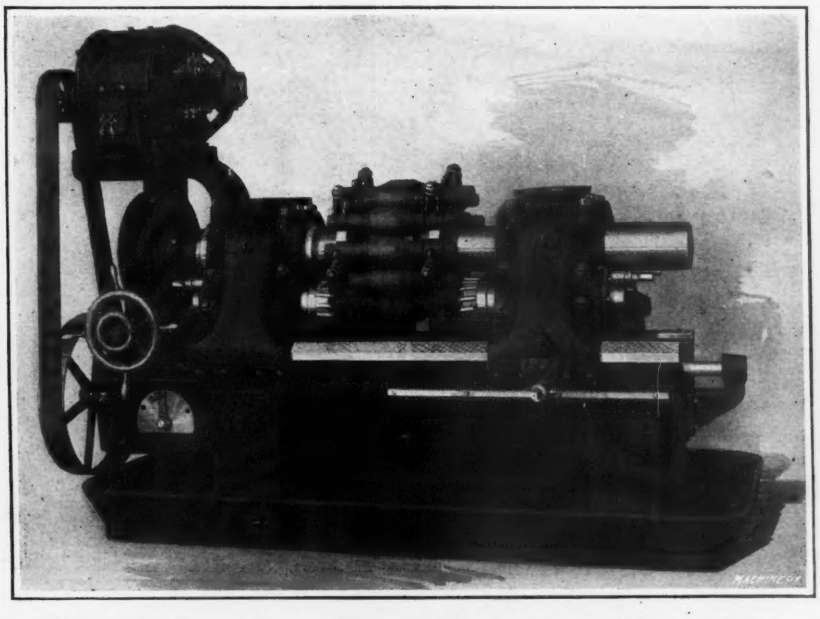


Fig. 1. Davis No. 1 Continuous Duplex Four-spindle Milling Machine for Automobile Camshafts, Crankshafts, etc.

The spindle head at the right end of the machine is adjustable along the ways of the bed similarly to the tailstock of a lathe, and after being set in any desired position it is clamped to the bottom of the ways. This arrangement adapts the machine for work of various lengths dependent upon the length of the bed. Each cutter-spindle has an endwise micrometer adjustment of two inches to permit accurate settings to be obtained. The spindles can be locked in place after the settings have been made. Two changes of speed for the cutters are obtained from speed-change gears placed in the left end of the bed. These gears are contained in a compartment filled with transmission oil, which insures adequate lubrication to all bearings and gears. A large oil reservoir is also provided in each spindle head to supply lubricant to the bearings and gears of these units.

The design of the work-holding fixture mounted on the mandrel depends upon the nature of the work to be machined, and different fixtures must be provided for each individual class. These fixtures are made in halves, clamped and keyed to the mandrel, and so can be mounted or removed easily. In some cases the fixture is supplied with clamps for holding the work to it, as shown in Fig. 1, where the machine is arranged for milling the ends of worm-shafts. However, in many instances, an automatic clamping apparatus is supplied.

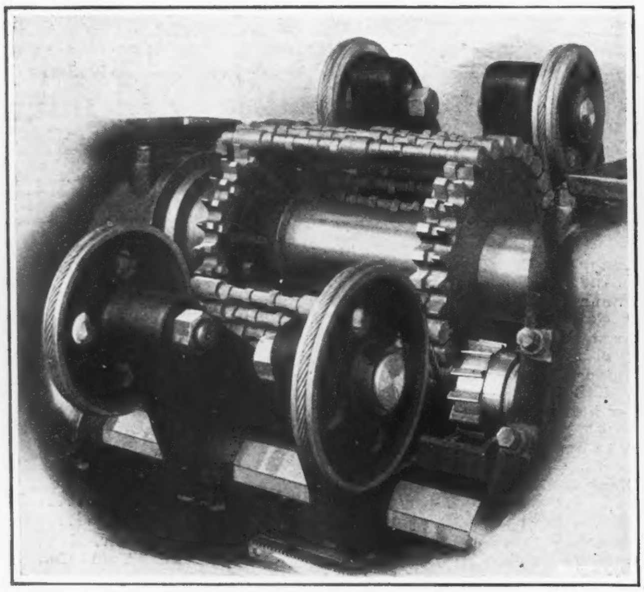


Fig. 2. Wire-cable Arrangement for keeping Parts on Work-holding Fixture

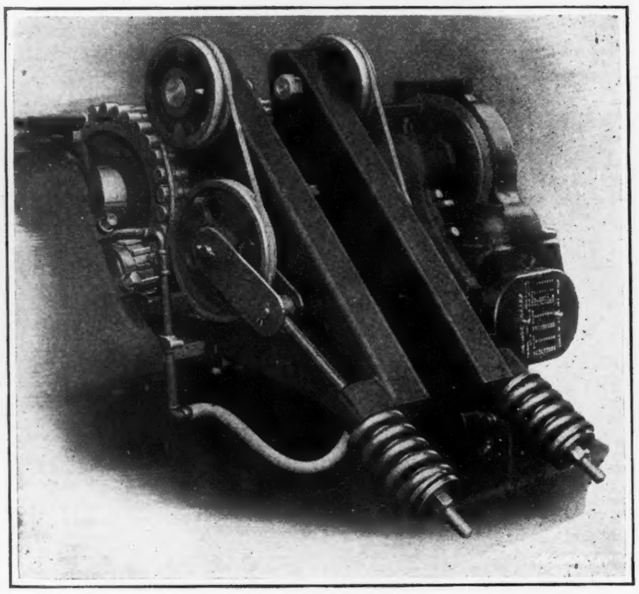


Fig. 3. Tension Device attached to Rear of Bed for keeping Cables taut on Pulleys and around Work

This clamping apparatus (Fig. 2) consists of two endless wire cables which pass over pulleys and beneath the work-holding fixture, thus preventing the work from falling out of the fixture when on the under side and being fed past the cutters. The pulleys are supported on brackets attached to the front and rear ways of the bed, and the cables are kept taut by heavy springs placed at the back of the machine, as shown in Fig. 3. With this arrangement the production of the machine is greatly increased as the work of the operator only consists of dropping the pieces in the notches of the fixture and removing them after they have been milled. This cable attachment can be easily removed from the machine when desiring to hold work on the fixture by other means. On account of roughing and finishing cutters being provided on each head, coarse feeds can be employed as the finishing cutters insure a high finish on the parts.

It is claimed that the rate of production depends entirely upon the operator, as the machine can be set to mill work as fast as the operator can insert and remove the parts. In milling camshafts with a cable-clamping arrangement, the average output is about 350 pieces per hour. However, if the work were held in place by clamps and bolts, the production would not be more than 100 pieces per hour on account of the time involved in clamping and unclamping the work. When milling castings with a cable-clamping arrangement it is sometimes necessary to make a jaw receptacle on the fixture for holding the castings in place, which insures a good path for the cable to travel in and prevents acute bends in the cable. The machine is built with beds of any desired length.

NEWTON CONTINUOUS MILLING MACHINE

In the October number of MACHINERY a continuous rotary milling machine built by the Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa., was illustrated and described. In the present number another model of continuous milling machine, brought out by the same company, is shown. As will be apparent by reference to Fig. 1, the same general principles of construction referred to in

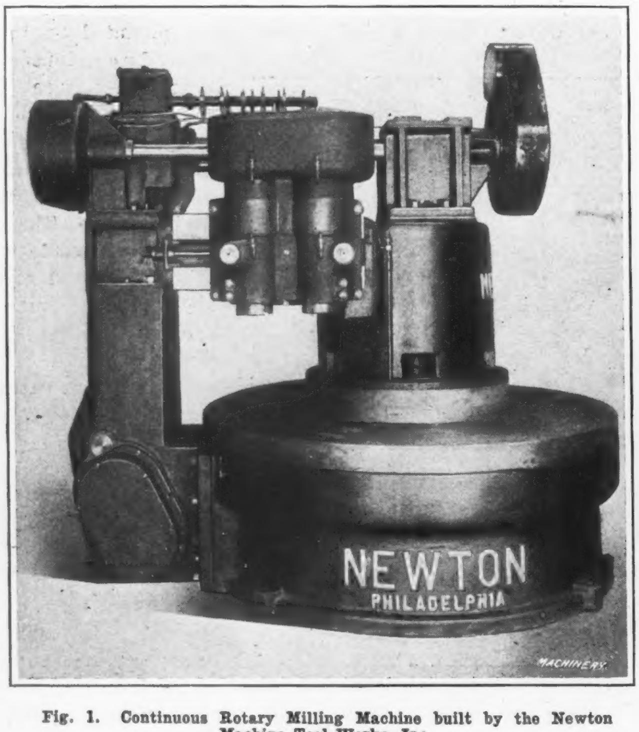


Fig. 1. Continuous Rotary Milling Machine built by the Newton Machine Tool Works, Inc.

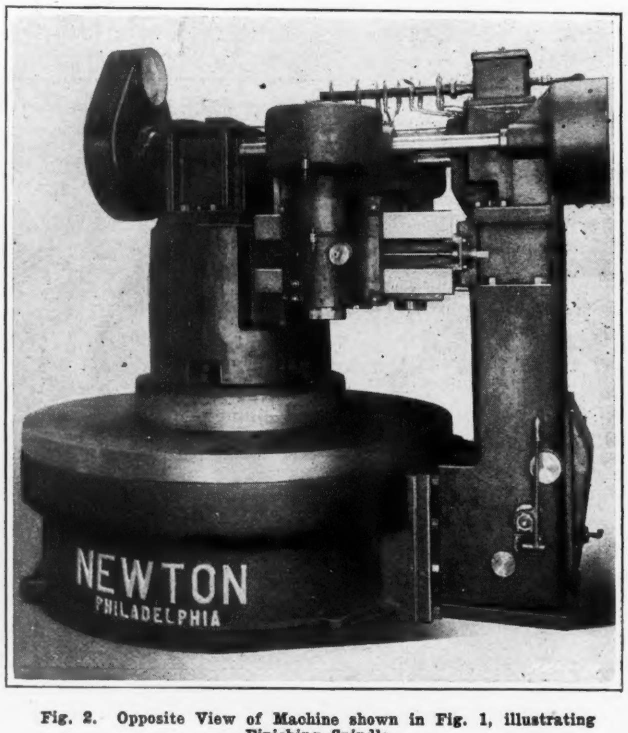


Fig. 2. Opposite View of Machine shown in Fig. 1, illustrating Finishing Spindle

the previous description have been applied. The base of the machine is circular and is provided with a central tapered column. The table casting is fitted over this tapered column, and, in addition, is supported by an annular bearing close to the periphery of the table. The table is 84 inches in diameter, and the depth from the annular bearing to the top of the table is 12 inches. In the center of the table there is a finished hub, 42 inches in diameter, which assists in locating jigs. The smallest diameter of the taper fit between the base column and the table is 36 inches.

As shown in Figs. 1 and 2, there is a central column, bolted and keyed to the base. This central column is made in one piece with a cross-rail upon which the spindle heads are carried. The object of making the cross-rail and the column in one piece is to eliminate, as far as possible, bolted connections. On the cross-rail, in the front of the machine, Fig. 1, there are two spindles for the roughing cuts, mounted in one housing. On the back of the cross-rail, as shown in Fig. 2, there is a single spindle for the finishing cut. This spindle is located at a distance of 42 inches from the center line passing through the two front spindles. The housings or heads in which the spindles are mounted may be moved along the cross-rail to any required position, so that the machine may be used for a variety of work, and so that the jigs and fixtures employed for holding the work may be designed in the most convenient manner. The outer end of the cross-rail is supported by a column which is bolted and doweled both to the base of the machine and to the cross-rail.

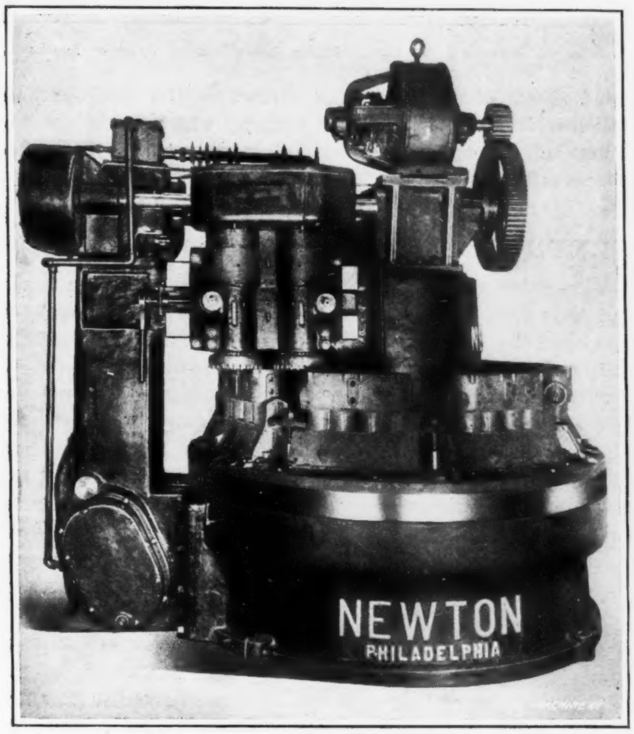


Fig. 3. Roughing Cutters at Work on Cylinder Castings

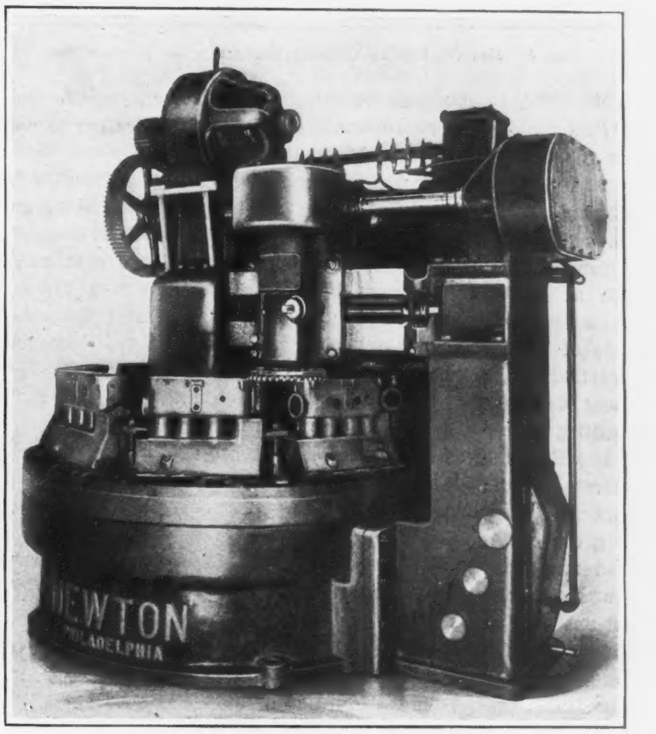


Fig. 4. Finishing Cutter at Work on Same Castings as shown in Fig. 3

Method of Driving the Machine

The motor by which the machine is driven is mounted on the top of the central column as shown in Fig. 3, and drives the jack-shaft through gearing, as indicated. At the extreme outer end of the cross-rail there is a gear-box from which motion is transmitted to the roughing and finishing spindles. The arrangement permits the rotative speeds of the spindles to be varied independently of each other, so that, while the speeds are predetermined and fixed, they may be changed when the grade of material or size of cutters is changed.

The rotative movement of the table is controlled by a predetermined fixed feed, but provision is made for changing this rate of rotation, if necessary, to suit any change in the grade of material. However, there is no means whereby the operator of the machine can increase or decrease the production of the machine at will, because the rotative speed when once determined remains fixed, and there must always be a given number of stations per hour passing the loading station; hence a predetermined number of pieces will always be machined per hour, if the operator gives the proper attention to the work. The drive to the table is by means of a herringbone gear, 81 inches in diameter.

The machine, when arranged for a given piece of work, is provided with a housing having a fixed distance between the centers of the roughing spindles, but different sizes of housings may be provided, with varying center distances between the spindles, according to the dimensions of the work. Generally, however, these centers are either 12 or 14 inches apart. Both spindles rotate inward—that is, the left-hand spindle rotates clockwise, and the right-hand spindle, counter-clockwise. Each of the spindles is provided with individual adjustments for setting the cutters to gages.

With a distance of 42 inches from the center of the roughing cutters to the center of the finishing cutters, the roughing operation is performed on any given casting before the finishing operation commences. Hence, the finishing cut is not affected in any way by the roughing operation; and due to the slight cut taken by the finishing cutter, any inaccuracy resulting from either dull roughing cutters or inequality in the casting is easily rectified by the finishing cutter. By dividing the work between the roughing and finishing cutters, the number of grindings of the cutters is also reduced, and it is possible to operate at much higher cutting speeds and table feeds than would otherwise be practicable. In many instances, a high degree of finish is not required, but increased production is obtained by the correspondingly faster feeds permissible when a finishing cut is taken.

The general design of the machine has been carefully worked out. All bearings, except the spindle bearings, are oiled by the cascade method of lubrication, the oil being pumped from a reservoir in the outer upright to a box on the top of this column, from which point it is distributed. All gears are enclosed and run in oil, and all essential gears are hardened. All bearings are sealed to prevent the escape of lubricating oil.

Examples of Work Done on the Machine

Fig. 3 shows the machine in operation taking roughing cuts on a cylinder casting, about 22 inches long and 11¼ inches

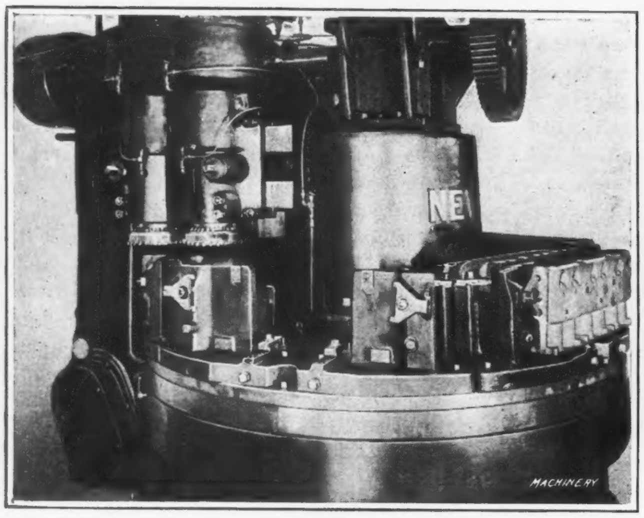


Fig. 5. Jigs for holding Cylinder Castings while rough-milling

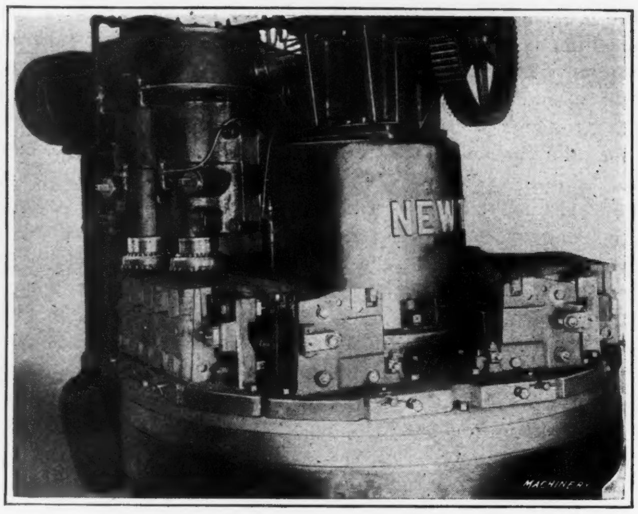


Fig. 6. Jigs used for Final Milling Operations on Cylinder Blocks

wide. Fig. 4 shows the finishing cutter at work on the same cylinder blocks. On this work a feed of 20 inches per minute on the maximum radius is used.

Fig. 5 shows a roughing operation and the method of jigging two castings in each jig, milling operations being performed on the base and manifold surfaces of cylinder castings. After the operations shown in Fig. 5 have been performed, the finished surfaces are bolted against the jigs for the subsequent operations of machining the top and the other side of the cylinder block, as shown in Fig. 6. From the illustrations, it will be noted that all the jigs are of the open front design, in order to permit of quick loading and unloading.

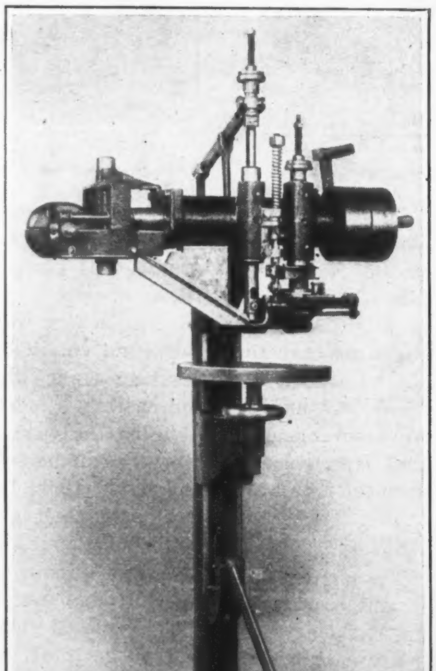
It will be noted that all the parts of these machines are extremely rugged, which is necessary on account of the fact that in many instances machines of this type are required to give service twenty-four hours per day. The machine is also made extremely heavy in order to absorb any of the vibrations caused by the three cutting actions that occur simultaneously. The character of the work usually milled on machines of this type does not require a great range of adjustment; hence, in a standardized model, such as shown any adjustment that is required is taken care of by the adjustment of the spindles and by the variations possible in the height of the jigs themselves.

The jigs are sometimes mounted on a sub-plate, as shown in Fig. 5. This is done because the particular factory for which the machines shown were designed makes four models of engines. Hence, it is often necessary to change quickly from one group of jigs to another. By having a sub-plate made in two pieces, only two sections have to be handled in changing from one model to another, and such a change is sometimes made two or three times in one week without inconvenience or undue delay.

Referring to Fig. 5, it will be noted that the roughing cutters do not mill upon the same radial line. The inner or right-hand cutter is further advanced than the left-hand cutter, so that it mills considerably in advance of the outer cutter. In this way, the two spindles, with a center distance of 14 inches, equipped with 12-inch cutters, are enabled to completely cover the surface of the work without any interlocking between the cutters, which latter method is generally recognized as a troublesome and difficult method of operation.

REYNOLDS SCREWDRIVING MACHINE

A machine which sets and drives small screws in place, and thus facilitates the assembling of light work, has been developed by the Reynolds Machine Co., Massillon, Ohio, and is shown in the accompanying illustration. Some of the applications for which the machine is especially suited are in driving electrical binding screws, switch-box screws, etc. This concern has hitherto built machines which automatically feed and drive screws of ordinary proportions, but the new machine handles screws having a length less than the diameter of the head. While designed especially for driving short screws, the machine is not limited to short work, and screws of ordinary lengths and sizes of heads can also be driven.



Machine built by the Reynolds Machine Co. for setting and driving Screws in Light Assembly Work

In operation, the screws are thrown at random into the magazine at the right of the machine, in which they are automatically arranged in single file and with the heads upward. They are delivered in this position into the inclined chute leading from the magazine to the lower end of the spindle. Opposite to and closing the lower end of the chute, is a finger provided with a recess in which one screw is received at a time and held in line with the spindle. A screwdriver bit is inserted in the socket of the spindle, and as the spindle is lowered by operating the foot-lever, the bit is engaged with the slot across the head of the screw, and the finger and screw are carried downward until the point of the screw comes in contact with the work. When this occurs, the finger is automatically withdrawn and the screw driven in place. The spindle is driven by friction, which can be adjusted to make it cease rotating when the screws are driven as tightly as desired. If preferred, the screws may be merely started into the work or driven to a uniform depth.

The table is 12 inches in diameter, and may be adjusted on the column to take work of various heights up to 15 inches. A screw is provided for per-

mitting close adjustments to be made. The foot-lever is pivoted well above the pedal to give an easy swinging action, and the position and amount of resistance can be adjusted to suit the operator. By operating the machine with a foot-lever, both hands of the workman are left free to handle the work. The spindle may be run at several hundred revolutions per minute, and the screws are driven tight almost instantly. The machine may be furnished with a pulley drive as shown, or with individual motor drive.

WARNER & SWASEY GEARED-HEAD TURRET LATHES

In this day of specialized manufacture, the feeds and speeds that can be used to the best advantage in machining any particular part are usually predetermined; therefore a turret lathe of enough flexibility to machine several surfaces of different diameters on one piece, or pieces made of different materials and to different dimensions, must necessarily have ample power and a wide range of both feeds and speeds. The Nos. 4 and 6 turret lathes now manufactured by the Warner & Swasey Co., Cleveland, Ohio, have a geared-head construction which is said to deliver four times the power transmitted by the ordinary geared friction head of the same size machine, and twice the power of the double friction back-geared type. Even with this increased power, less effort is required to move the controlling levers; consequently the machine is easier to operate.

The front view of the No. 6 turret lathe with a geared head is illustrated in Fig. 1, while the rear view of the same machine may be seen in Fig. 2. The first model of this type built, has been thoroughly tested under every condition that might be encountered in service, and six machines of each size have been installed in outside shops for similar experimenting. The results obtained from all these machines have been very satisfactory.

Fig. 3 shows a view of the geared head with the cover removed, from which it will be seen that the steel gears are of a coarse pitch and have wide faces. The gears run in a bath of oil which also lubricates the bearings. Two sets of gears are mounted on the front shaft, while a third set and the reverse friction clutch are mounted on the back shaft. Twelve spindle speeds and a reverse rotation are obtained. Another advantage claimed for machines of the geared-head construction is their adaptability to the various types of motor drive. The head may be geared directly to the motor or driven from it by means of a chain or belt.

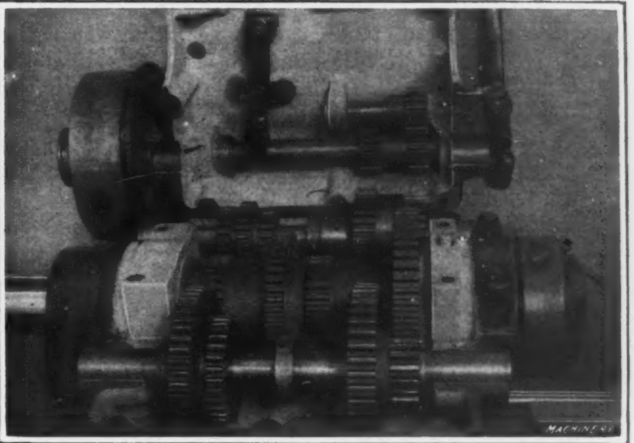


Fig. 3. View of Geared Head with Cover removed showing Gears in Place

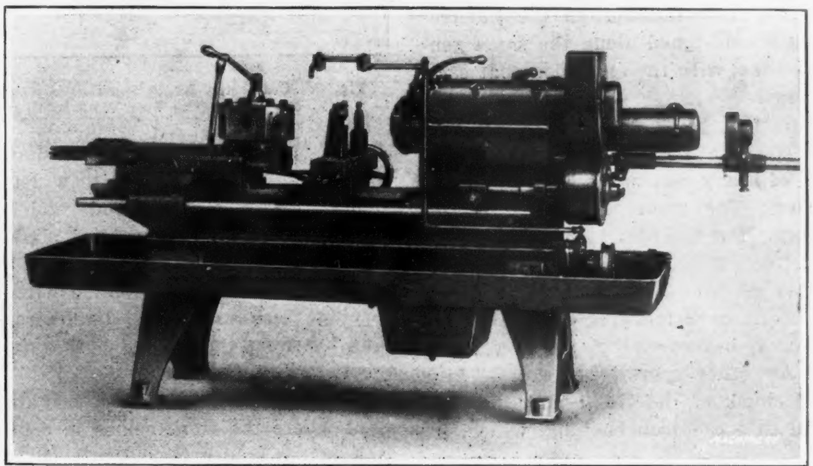


Fig. 2. Rear View of Geared-head Turret Lathe illustrated in Fig. 1

The No. 6 turret lathe can be equipped with the standard carriage used on Warner & Swasey turret lathes one of which is shown on the machine illustrated, or with a heavy-duty carriage that is specially valuable when taking heavy cuts or performing heavy forming operations. A range of six power cross-feeds is provided on this heavy-duty carriage for facing, forming, and cutting off work at various speeds. The No. 4 turret lathe is equipped with a standard carriage. The maximum capacities of this turret lathe are as follows: Diameter of bar stock, 1½ inches; length turned, 10 inches; swing over bed, 16 inches; and swing over cross-slide, 7 inches. The maximum capacities of the No. 6 turret lathe are as follows: Diameter of bar stock, 2¼ inches; length turned, 12 inches; swing over bed, 20⅜ inches; and swing over cross-slide, 9¼ inches.

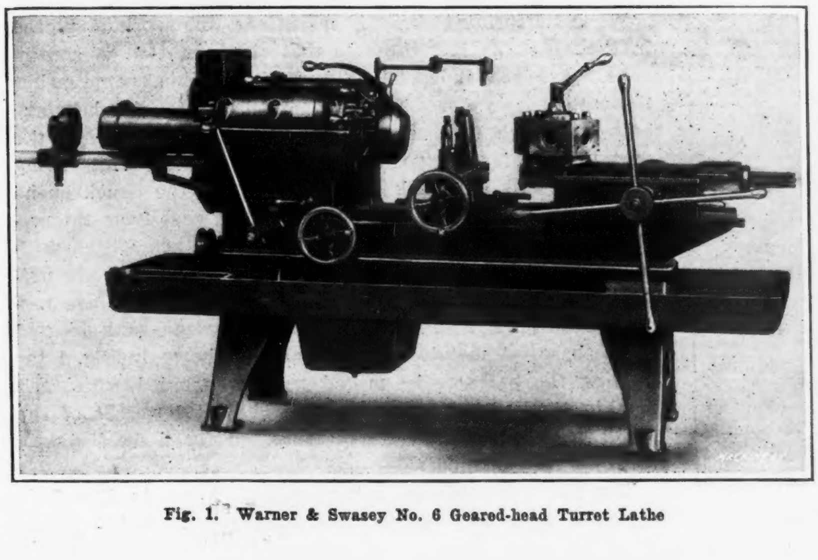


Fig. 1. Warner & Swasey No. 6 Geared-head Turret Lathe

"MENO" RUST REMOVER AND CLEANSER

The "Meno" rust remover and cleanser is a scientific combination and blending of certain chemical ingredients, which in combination produce an electro-chemical action resulting in rapidly loosening and dissolving rust, grease, oil, dirt, carbon, paint or any other foreign substance adhering to metal, irrespective of its age or hardness. The action of the cleanser is said to cease automatically when contact between the cleanser and the metal is established, so that it will not injure or mar the surface of the metal itself in any way. There are two methods of using the preparation, as follows: (1) Apply it to the machine or part with a brush and allow it to remain for a short time, then brush or rub

it off, leaving the metal bright and clean. (2) Mix the preparation in a vat, tank or container with water, then attach the machine or parts to a wire or chain so that they will hang in the solution. No further attention is required, since the process of cleaning goes on while the parts are immersed. It is stated that the preparation is absolutely safe in every way and that it will not burn or explode. Another important point claimed is that it will not cause corrosion or rust to form; in fact, it protects the metal and makes it exempt from corrosive or disintegrating action for a long period after it has been treated by this preparation. The same solution may be used many times as it does not deteriorate or lose its cleansing power. Peter A. Frasse & Co., 417 Canal St., New York City are the sole distributors.

CRAFTSMAN CONTINUOUS ROTARY MILLING MACHINES

The line of continuous rotary milling machines here described and illustrated is built by the Craftsman Tool Co., Conneaut, Ohio. The machine shown in Fig. 1 is the first of this line to be placed on the market. It was originally designed for the purpose of castellating small nuts, but its success when used not only for castellating operations, but for a wide range of light milling operations as well, led to the building of the No. 2 and No. 3 machines, shown in Figs. 2 and 3, respectively. As will be noted from the illustrations, the latter machines are designed along the same general lines as the No. 1 machine, with the exception that each is provided with two chucks.

Reference to the illustrations will show that these machines are designed to combine rigidity with simplicity. The frames are composed of heavy castings, which rest upon substantial cast-iron bases. The principal feature is the continuously rotating chuck. For the Nos. 1 and 2 machines this chuck is made 10½ inches in diameter. Each chuck consists of three carburized machine-steel plates. The standard outer plates used for either castellating or screw slotting are about ¾ inch thick, but special plates of various thicknesses are supplied for other operations.

Referring to the single chuck of the No. 1 machine, the left-hand plate is attached to a cast-iron bushing, which, in turn, is pinned to the central shaft of the machine. The right-hand plate is slotted to a depth varying from 2 to 3 inches, thus forming an independent jaw for holding each part to be milled. The central plate is furnished in varying diameters according to the operation to be performed, and the standard chuck is supplied with three of these plates of varying thicknesses and diameters. The right-hand plate runs loose on the shaft, so that it is permitted to swivel or tilt.

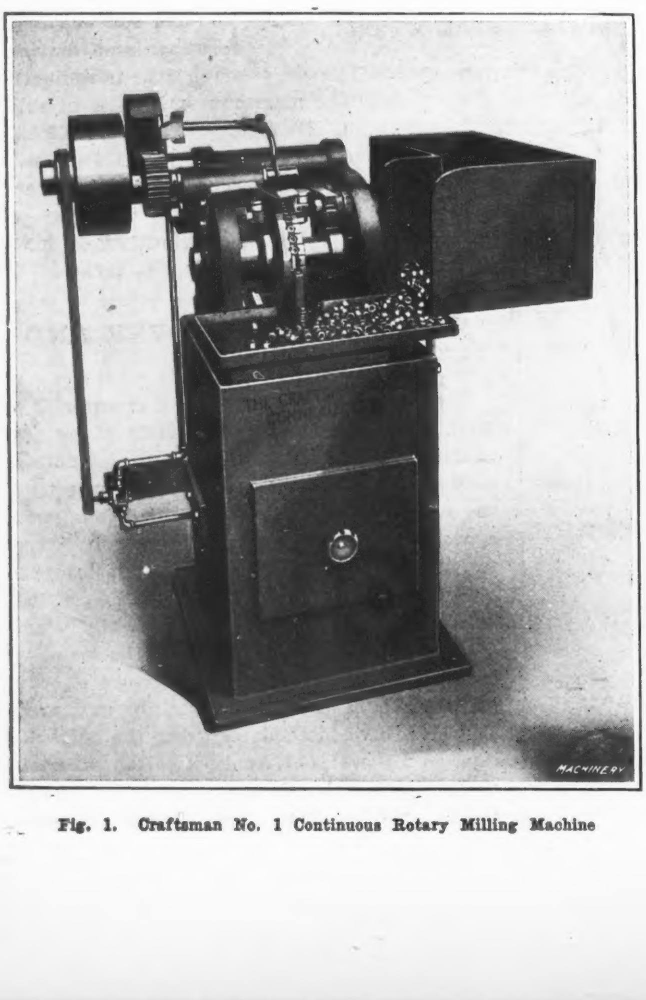


Fig. 1. Craftsman No. 1 Continuous Rotary Milling Machine

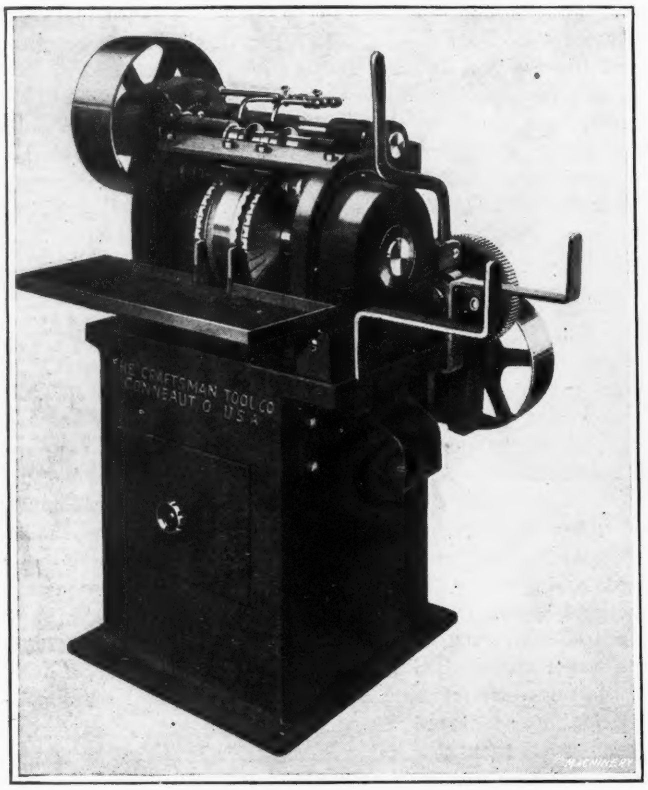


Fig. 2. Craftsman No. 2 Continuous Rotary Milling Machine, which has Two Work-holding Chucks

The chuck rotates between two steel rollers located at the point where the work comes in contact with the cutter. As each part is held independently, difficulty arising from variations in size is overcome. A spreader is placed in the front of the chuck which serves to keep the chuck continuously open at the point where it is fed. The cutter is driven by a hardened and ground steel spindle carried in a rocker arm. The rocker arm provides a means of adjustment for the depth of slot and variations in size. The cutter-spindle is back-geared, and the central shaft, which propels the chuck, is worm-driven, thus insuring ample power. The worm drive is provided with a clutch controlled by a conveniently located handle, and slip gears are supplied, giving ten changes of feed for the Nos. 1 and 2 machines.

When performing milling operations, the work is placed in the chuck as it rotates so that the operation is continuous. As each independent jaw of the chuck approaches the cutter, it is closed automatically by two roller bearings between which it passes; the work which rests upon the central plate is thus positively held in position while being machined. As the work leaves the cutter, the chuck opens automatically, and the parts drop out and pass from the machine through a chute into a suitable receptacle. Slab milling, straddle milling, and plain milling operations are performed on a wide variety of parts. The machines are regularly equipped with a pump and lubricating tank located in the base. A metal container such as shown in Fig. 1 for holding the parts to be milled is also included with each machine and also a countershaft. The total weight of the No. 1 machine and countershaft crated for domestic shipment is 1430 pounds.

The No. 2 continuous rotary miller shown in Fig. 2 is equipped with two chucks, and consequently has a wider

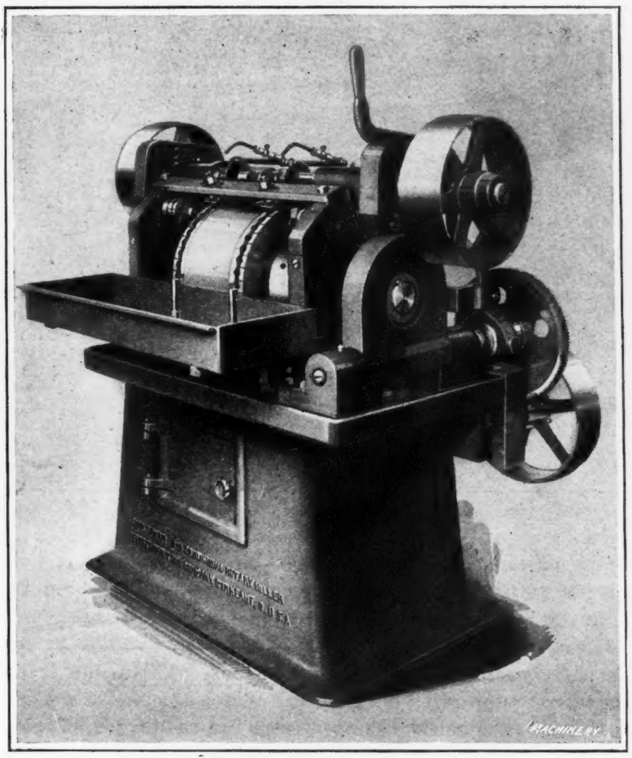


Fig. 3. A Larger and Heavier Design of Continuous Rotary Milling Machine

housing and larger pulleys than the No. 1 machine. By applying two chucks, a much higher production is obtained, except on very small parts where one chuck will mill the parts as fast as they can be inserted by the operator. When castellating ½-inch nuts, the No. 1 machine is limited to the production of 1200 slots per hour, or 400 complete nuts; whereas, the No. 2 machine will give a production of 2400 slots per hour, when the operator becomes accustomed to the increased speed. The machine frame is constructed with pillow blocks, so that the shaft which carries the chucks can be rolled out of the machine and a change of chucks effected with very little delay. This feature is made necessary by reason of the chuck-plate support or middle disk being shrunk on the shaft, which makes it impossible to remove the shaft from the side of the machine, as is conveniently done in the No. 1 machine.

While the No. 3 machine shown in Fig. 3 follows closely the design of the No. 2 machine, there are some essential differences of construction. The No. 3 type is provided with two rocker arms and two driving pulleys. This gives greater power and at the same time permits two adjustments for depth of cut to be made so that two separate operations can be handled by the machine at the same time. The larger chucks and heavier construction of the No. 3 machine give it an increased range, so that parts up to 2½ inches in diameter by 6 inches in length can be readily machined and proportionately heavier cuts made. The compound feed-gears with which the No. 3 machine is equipped give thirty changes of feed. The domestic shipping weight of this machine is 3400 pounds.

WEBSTER & PERKS PLAIN MANUFACTURING GRINDING MACHINE

The Webster & Perks Tool Co., P. O. Box 1301, Springfield, Ohio, has recently brought out a 6- by 30-inch plain cylindrical grinding machine, which is shown in the accompanying illustration. This machine is designed for use as a rapid production manufacturing grinder for either tapered or straight cylindrical grinding on centers. Rigid construction and accuracy in building the machine are claimed as the features that make it possible to obtain a high productive capacity on work having very close tolerances.

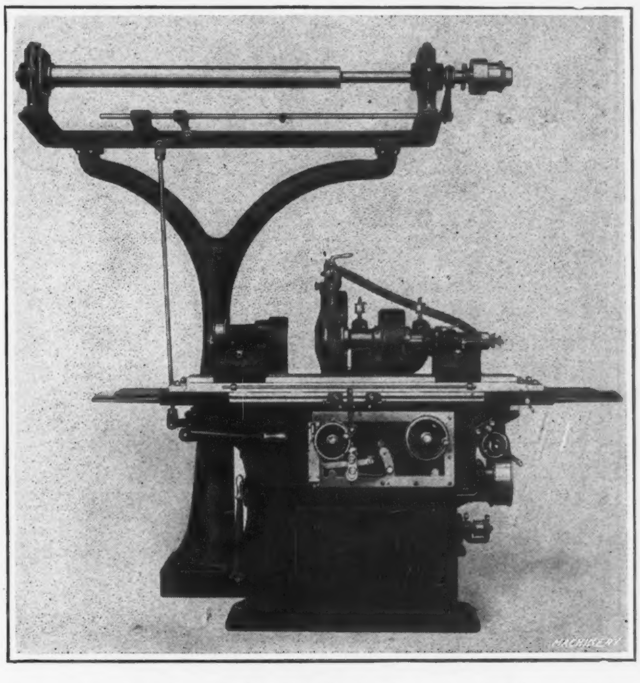
The machine is furnished with either an overhead countershaft for suspension from the ceiling or a countershaft attached to the floor at the back of the machine. The latter type of countershaft may be driven directly from the line-shaft, through the medium of tight and loose pulleys, or the pulleys may be eliminated and a motor connected to the main shaft of the floor stand by means of a coupling. The work drive drum in this case is supported by a column secured to the countershaft base.

The base of the machine, including a large water reservoir, is cast in one piece. Three planed pads are provided on the bottom of the base to facilitate leveling up the machine. The bed is secured to the base by means of large cap-screws and is ribbed to secure stability and alignment of the ways. The vee- and flat-ways are made deep and wide to give large bearing surfaces, and are provided with roller oilers to insure proper lubrication. The sliding table is of rigid construction and is provided with large bearing pads which support the swivel table. The table travel is automatic, and controlled by adjustable dogs secured to the edge of the table by means of a T-slot. The dogs are provided with screws and lock-nuts for fine adjustments. A smooth and steady movement is imparted to the sliding table through the medium of accurately cut spur gears operating at a ratio of 64 to 1 from the transmission drive.

The swiveling table, mounted on the sliding table, swivels on a large hardened and ground center stud fitted in a hardened and ground steel bushing pressed into the table. An adjusting screw and clamps at both ends of the table provide means of adjusting and clamping the table at any "degree" or "inch" graduation marked on the right-hand clamp.

The headstock spindle is driven by fully enclosed gearing which runs in oil. Either live or dead center grinding may be done. The spindle is made of chrome nickel steel, is hardened, ground, and lapped, and runs in long bronze bearings with provision for adjusting to compensate for wear. The footstock is provided with an adjustable spring for holding the center in the work, and with a lever for withdrawing. A locking device is also provided to hold the center rigidly. The wheel-truing device is mounted on the footstock to facilitate truing the wheel without removing the work.

The wheel stand is provided with gibs to prevent its rising in case of accident. The wheel-spindle is made of chrome-nickel steel, hardened, ground and lapped, and mounted in bronze bearings with provision for adjusting to compensate



Plain Manufacturing Grinding Machine built by the Webster & Perks Tool Co.

for wear. These bearings are mounted in ball and socket type bearing housings to secure proper alignment.

The cross-feed, table drive and reversing mechanisms are assembled in a single unit and bolted to the front of the machine, making all working parts accessible for adjustment or repair. The largest diameter that can be ground with a full-sized wheel is 10¼ inches, and the greatest length between centers is 32 inches. The swivel table is graduated to grind tapers up to 3½ inches per foot and up to 8 degrees. The smallest amount of reduction by automatic cross-feed is 0.00025 inch, and the greatest amount 0.005 inch. The cross-feed handwheel is graduated to indicate reductions of 0.00025 inch. The four work-speeds range from 48 to 192 revolutions per minute, and the eight table speeds give traverse speeds of from 6 to 94 inches per minute. The two grinding wheel speeds are 1680 and 1920 revolutions per minute. The machine with unit countershaft secured to the floor at the rear of the machine occupies a floor space of 66 by 116 inches, and weighs approximately 5050 pounds.

OAKLEY NO. 3 UNIVERSAL TOOL-ROOM GRINDER

The No. 3 universal tool-room grinder now being manufactured by the Oakley Machine Tool Co., Oakley, Cincinnati, Ohio, has incorporated in its design certain new features intended to insure, during the life of the machine and under all working conditions, such essential features as accuracy, rigidity, and convenience of control. The longitudinal feed may either be hand-operated or driven by power. The fast hand feed is operated through a rack and pinion, either from the front or rear of the machine by a long hand-lever (see Fig. 1). A small handwheel in front of the saddle controls the slow hand-feeding movement. The power feed is driven by a single belt from a countershaft, and constant belt tension is maintained irrespective of the position of the knee. There are three feed changes obtained through a cone pulley.

The operating and reverse levers are directly under the operator's hand. Hardened chrome-nickel steel is used for all reverse mechanism clutches. The cross-feed is operated by a large diameter handwheel, either from the front or rear of the machine, and there are micrometer dials at both ends

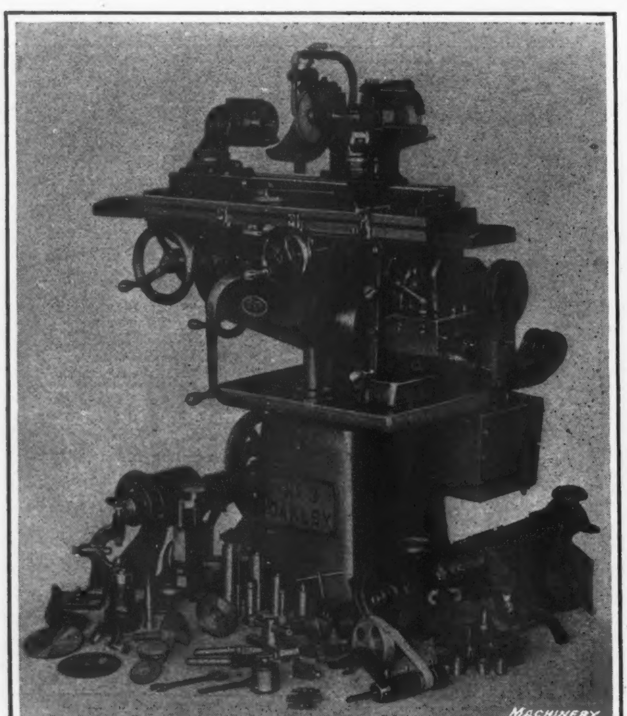


Fig. 1. Oakley No. 3 Universal Tool-room Grinder

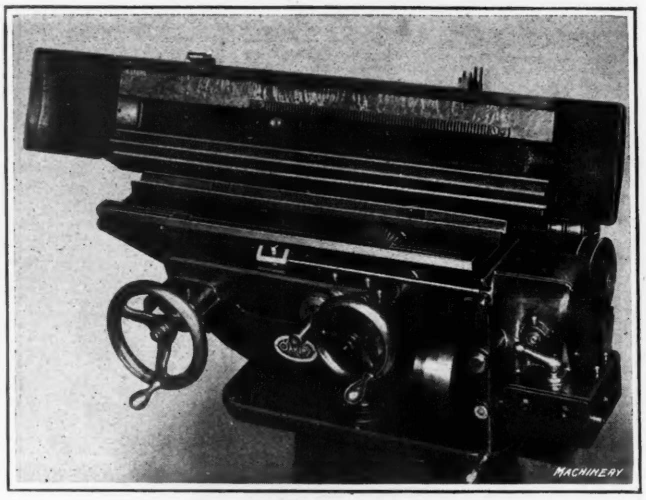


Fig. 2. Detail View of Slide and Saddle

of the cross-feed screw. Another large handwheel is used for the vertical feed, which has a micrometer dial on the elevating shaft. The thrust is taken by ball bearings.

The slide of the machine is aligned to the saddle by vee and flat bearings of liberal dimensions. This slide is designed to maintain true alignment during the life of the machine, and it is easily removed from the saddle for cleaning (see Fig. 2). The saddle and knee have V-bearings; and in the case of the slide, saddle, and knee there are no gibs or adjustments for the operator to tamper with. The entire slide bearings are oiled through one centralized oil-cup. The wheel-head swivels on the column 180 degrees either side of the central position. The wheel-spindle runs in dustproof, taper, bronze bearings. The work-head has a No. 12 B. & S. taper for receiving the shanks of large end-mills. This work-head swivels in horizontal and vertical planes.

The range of this machine is as follows: Longitudinal movement, 17 inches; vertical movement, 10½ inches; cross movement, 9 inches; maximum swing, 10 inches; maximum distance between centers, 20 inches. The table surface is 5¾ inches wide, and 33¾ inches long. The automatic feeds are 6½ inches, 11⅜ inches, and 19½ inches per minute.

LANDIS CAMSHAFT GRINDING ATTACHMENT

The efficiency of an automobile engine depends to a great extent upon the accuracy of the camshaft, and in the development of engines up to their present high stage, the tolerances allowed on the cam surfaces of these members have been gradually reduced until it has become necessary to employ grinding machines in order to produce them within the required limits of accuracy. To meet this condition, the Landis Tool Co., Waynesboro, Pa., has developed a grinding attachment which is shown in Fig. 1 mounted on a Landis 10-inch plain self-contained grinding machine. This attachment swivels on shaft *A* which runs along its entire length, rocking the work back and forth against the grinding wheel to suit the contour desired on the various cam surfaces of the camshaft. The rocking movements are controlled by a master cam and roller contained in the headstock of the attachment.

In Fig. 3 this headstock is shown with the cover removed, while Fig. 2 shows the details of construction. By referring to these illustrations, a description of the manner in which the oscillatory movements of the attachment are controlled can be readily followed. The work is placed between the centers of the headstock and tailstock and driven by means of a dog attached to the headstock end which has an arm located between lugs on driver *A*, Fig. 2. This driver is mounted on spindle *B*, and is adjustable to facilitate the setting of the camshaft in the proper relation to the master cam *C*. The spindle is driven through the worm-wheel *D*

near the left end of the headstock. The master cam consists of a series of cam surfaces to suit the cams on a camshaft, but they are much larger in diameter than the camshaft surfaces so as to reduce errors. This master cam is made of a solid piece of steel, is a taper fit on the spindle, and is held in the proper location by means of nut E.

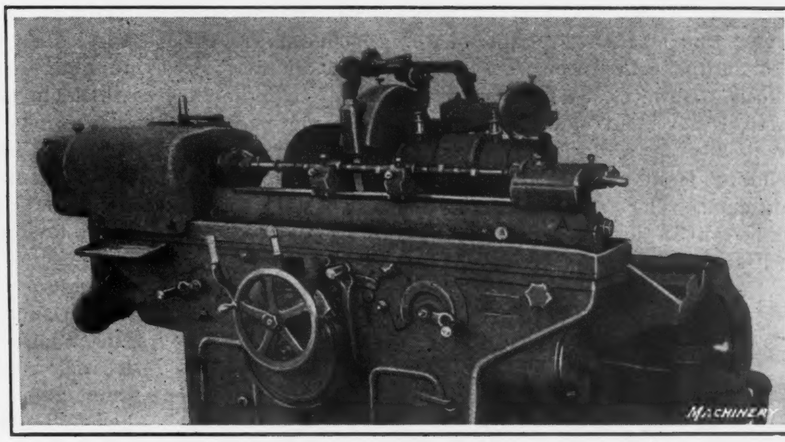


Fig. 1. Landis 10-inch Plain Self-contained Grinding Machine provided with Attachment for grinding Automobile Camshafts

Roller F is brought in contact with the master cam when the surface of a camshaft is being ground, and as spindle B revolves and a lobe of the master cam comes in contact with the roller, the entire attachment is rocked toward the wheel to suit the work. The master cam is kept in contact with the roller by means of compression springs, the tension of which is adjustable to suit various conditions. When any cam surface of the camshaft is completed, roller F must be shifted to the surface on the master cam corresponding to the cam on the camshaft which is to be ground next. This is accomplished by turning lever G, Fig. 3, which causes the rotation of shaft I, Fig. 2. It will be noted that shaft I is provided with a continuous groove into which a plug attached to the roller projects, and as the shaft is turned one revolution, the roller is advanced an amount equal to the pitch of the groove and thus brought into position on the next cam surface of the master cam. The relative positions of the roller along the master cam are indicated by pointer H, Fig. 3. Brake J, is provided at the left-hand end of the spindle for the purpose of compensating for any lost motion at the time the pressure of the work against the grinding wheel is reversed when the latter passes over the lobe of a cam.

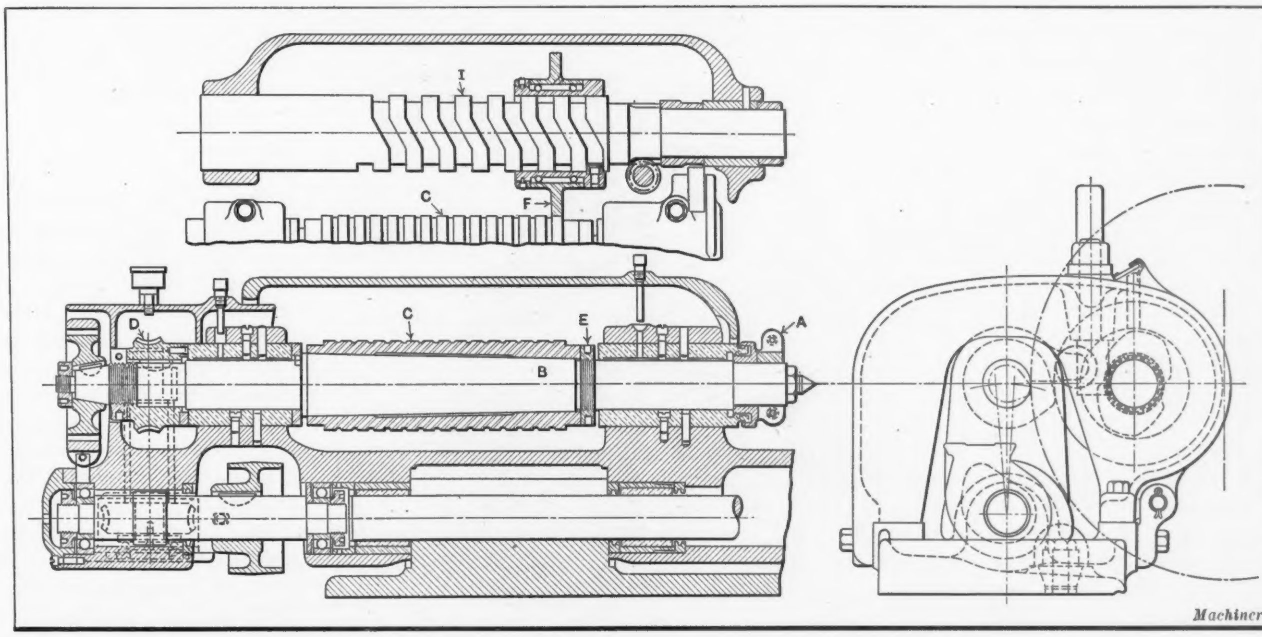


Fig. 2. Headstock End of Grinding Attachment developed for machining Automobile Camshafts

In designing this attachment, rigidity has been obtained by making the main casting or swinging bracket of a tubular cross-section, by having it well supported directly under the master cam, and by locating the work-centers close to the machine bed. It is claimed that this construction balances the swinging bracket and eliminates strain. On account of the work being held directly above the fulcrum center, its vertical movement is reduced and the point of contact between the grinding wheel and the work is kept within a small arc, thus making negligible the difference in the contour of cams caused by the changing diameter of the grinding wheel. As the master cam is mounted directly on the headstock spindle and is substantially connected and in line with the work, lost motion and errors are eliminated.

The most accurate results are secured when the grinding wheel is of the same diameter as the roller used in contact with the model cam when the master cam is being generated. This condition results from the point of contact between the work and grinding wheel traveling above and below the wheel center.

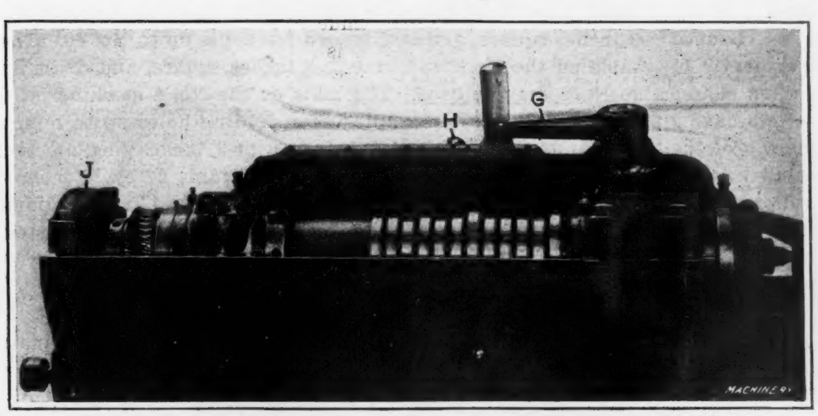


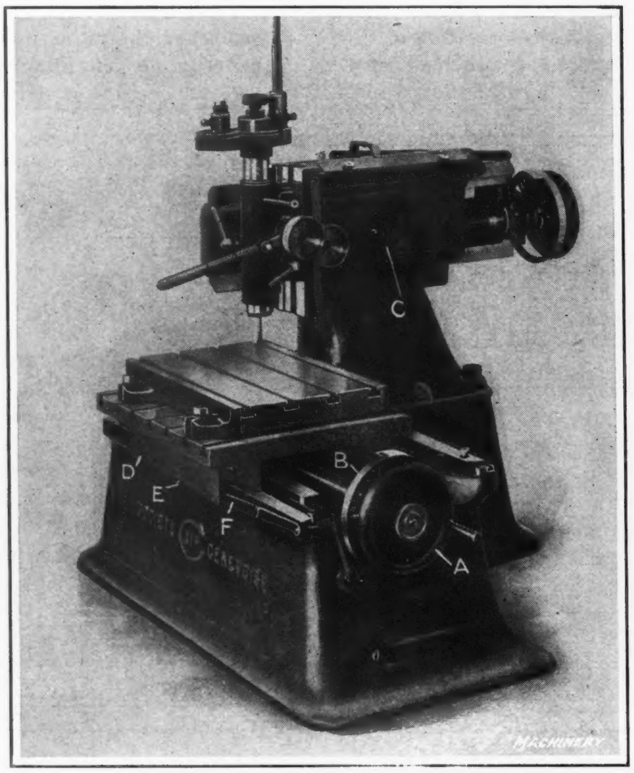
Fig. 3. Headstock End of Grinding Attachment with Cover removed, showing Master Cam and Roller used to give Oscillatory Movements to Attachment

The more this contact point varies from the horizontal center line of the wheel, the more pronounced the variation in the contour of cams ground with different sized wheels. However, as previously mentioned, there is little vertical movement of the work so that the movements are practically in a horizontal plane and the travel of the grinding point above and below the wheel center is at a minimum. The grinding attachment described in the foregoing can be furnished in the following sizes: 5½ by 26½ inches; 5½ by 36 inches; and 5½ by 52 inches.

S. I. P. LOCATING MACHINE

The accurate locating of holes on work of a precision nature, such as jigs and fixtures, by means of the customary button or disk methods is necessarily a long operation, and the results obtained are limited by the skill of the workman and the care taken in making the settings. In order to facilitate such work and to permit the holes to be accurately drilled or bored while located, the Société Genevoise d'Instruments de Physique of Geneva, Switzerland has developed the machine shown in the illustration, and known as the S. I. P. locating machine. The sales agent for this machine is the Golden Co., 405 Lexington Ave., New York.

In using this machine, the work is placed on the table which can be adjusted in a longitudinal direction by means of a lead-screw that engages with a nut on the under side of the table. This lead-screw is rotated by turning handwheel *A*. An index-wheel *B*, which is graduated to 0.0005 inch and has a vernier reading to 0.0001 inch, is provided for accurately indicating any amount of movement given to the table. A scale is provided at the rear of the bed to indicate the position of the table in relation to the zero mark.



S. I. P. Locating Machine developed for the Accurate Locating and Drilling or Boring of Holes in Jigs and Fixtures

The spindle of the machine is held in a bracket attached to the face of slide *C* which is mounted at the top of the column. This spindle can be moved transversely across the table by turning a lead-screw which engages with a nut on the slide. A handwheel and index-wheel similar to *A* and *B*, respectively, are also mounted on the end of this lead-screw, and the graduations and the vernier of this index-wheel are identical to those of wheel *B*. Both index-wheels are clamped in position by friction, and can be turned independently of the handwheels, so that they can be set to zero when changing the setting of the table or slide. Both lead-screws have a pitch of 0.1 inch. A scale is also provided at the top of the slide to indicate its position in relation to the column.

The table is provided with spring-supported rollers which relieve the weight of the table on the ways of the bed. This arrangement reduces the friction between the table and the bed and helps to maintain the precision of the machine. The tension of the springs that support the rollers is adjustable. An important feature of the machine is the device provided for correcting faults of the lead-screws used to secure movements of the table and slide. The correction device for the table screw can be seen in the illustration. It will be noted that a cam-plate *D* is attached to the front of the table; this cam-plate has a correction groove along its lower edge. As the table is moved along the bed, the irregular contour of this curve transmits an up and down movement to pin *E*, which, in turn actuates lever *F* and causes the vernier at index-wheel *B* to move in conformity with the faults of the screw. This arrangement automatically gives correct readings for any position of the table. The correction device for the slide screw is designed along similar lines and is placed along the top of the slide.

The accessories furnished with the machine include a locating microscope, a goniometric microscope, a calibration or correction control microscope, a calibrated standard scale, and a circular table about 10 inches in diameter. The locating microscope is provided with adjustable crossed hair lines, and magnifies 20 diameters. It is used for locating holes on new work, and for checking the centers of holes laid out by some other means, or holes already machined. It may also be used for testing the parallelism of lines drawn on any plane surface. The goniometric microscope has one stationary and one adjustable hair line and also magnifies 20 diameters. The graduated circle is divided into half degrees, and readings may be made to one minute by means of a vernier. It is designed for the measurement of angles and for use when laying out polar coordinates.

The calibration or correction control microscope is provided with two parallel hair lines and magnifies 50 diameters. It is used in conjunction with the standard reference scale to be described later. This microscope and the scale are designed for the periodic verification of the precision of the lead-screws. The calibrated standard scale just mentioned is graduated to 0.1 inch over a length of 8 inches. It is a nickel-steel bar having approximately the same coefficient of expansion as hard steel, and is enclosed in a metal case provided with a cover. The purpose of this case is to prevent the scale from coming in contact with any object which might mar its accuracy. The circular table is graduated in degrees and may be set to one minute of an arc by means of the vernier. This table is also designed for working to polar coordinates.

The machine described in the foregoing is built in four sizes, Nos. 1, 2, 4, and 5. The No. 1 machine has a table 3 inches square, and is intended for drills up to No. 60. The table on the No. 2 machine is 8 inches square, and drills up to No. 8 may be used. The table on the No. 4 machine is 16 by 20 inches; this machine is for drilling holes up to 1 inch in diameter or for boring holes up to 3 inches in diameter. The No. 5 machine is provided with a table 24 by 32 inches, and is suitable for the drilling of holes up to 1 inch in diameter, or for the boring of holes up to 4 inches in diameter.

LANGHAAR BALL BEARING

A ball bearing embodying in its design a number of new patented features has been brought out by the Langhaar Ball Bearing Co., Aurora, Ind., and is known as the Langhaar self-adjusting (L-S-A) ball bearing. In the design of this bearing it has been endeavored to produce a ball bearing

which would fulfill the requirements and principles of ball bearing design that, from experience and tests, have been laid down by research engineers in the past and that were stated in the review of basic laws of ball bearings published in the Transactions of the American Society of Mechanical Engineers, May, 1907. These principles are briefly: (1) The load a bearing will carry increases with the size and the number of balls; hence, the largest possible balls and the greatest number in any given size of bearing is of first importance; (2) the ball races must be strong enough to resist bending and breaking; (3) each ball must have only two points of contact with the races; (4) the ball races must be curved and have a curvature slightly greater than the balls; (5) the design must provide for true rolling contact, as otherwise there will be sliding and grinding between the balls and races; (6) the bearing should have equal capacity for radial and thrust load; (7) perfect fit should be assured by a self-adjusting feature.

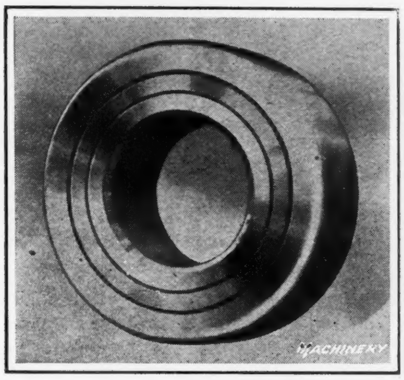


Fig. 1. L-S-A Ball Bearing

Fig. 1 shows the L-S-A ball bearing assembled, and Fig. 4 illustrates the various parts of which it consists. Fig. 3, which is a sectional view, gives the best idea of the design and action of the bearing. As will be seen, there are two rows of balls, each having independent ball cages *A*, Fig. 4. Between the rows of balls there are two independent rings *B*, between which are placed springs *C*, by means of which the right pressure upon the balls is assured, and a self-adjusting feature obtained. The inner ball race *D* is solid, but the outer ball race *E* is made in two parts as shown, the two sections interlocking with each other in practically the same manner as jaw clutches, and are pinned together so that they form a solid unit when assembled. The springs *C* are flat springs, slightly curved, and are assembled between the two rings *B* in the manner indicated in Fig. 2.

By referring to Fig. 3 it will be noted that proper ball rolling contact under load is obtained by having the lines of contact of the balls and races form cones like bevel gears. Each ball may be imagined to be a bevel gear rolling upon the races as bevel pinions in an automobile differential roll with their mating bevel gears. This method of construction obviates spinning and grinding motion and decreases wear. The small wear that evidently must always occur where two parts are in moving contact with each other is compensated for by the self-adjustment feature. Another advantage claimed is the independent separator for the two rows of balls, whereby the one row of balls will never act as a drag on the other. The double row of balls also makes the bearing wide enough in proportion to its diameter, so that it will seat itself properly in its housing. The two rows of balls will always carry an equal share of the radial load, because of the rings between the two rows. These rings keep the rows in balance, and likewise serve as a guide for their rolling motion. It will also be noted that in the design shown, the largest possible size and number of balls can be used in a given size of bearing.

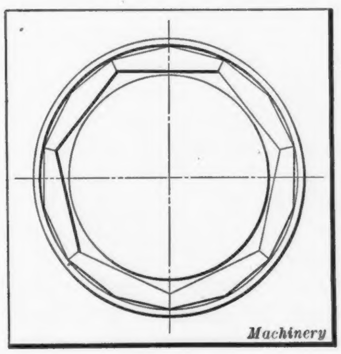


Fig. 2. Springs assembled between Ball Bearing Rings

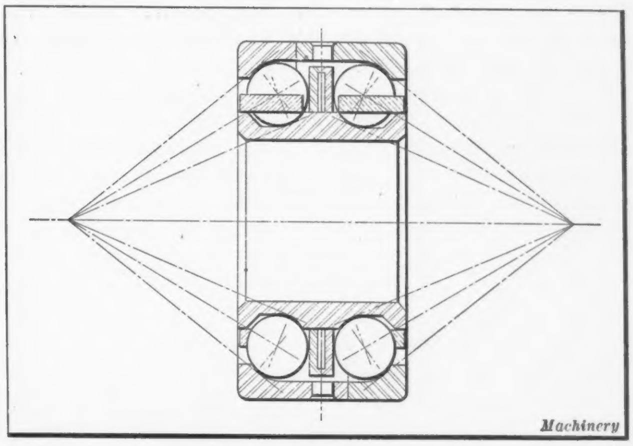


Fig. 3. Sectional View of L-S-A Ball Bearing

The method of uniting the outer races is patented. This joint provides for a solid metal-to-metal abutment, so that the bearing cannot be injured or compressed by an external lock-nut. The pins which hold the two sections together are made of hardened steel, and so proportioned that the strength of the assembled race will be many times greater than service requirements.

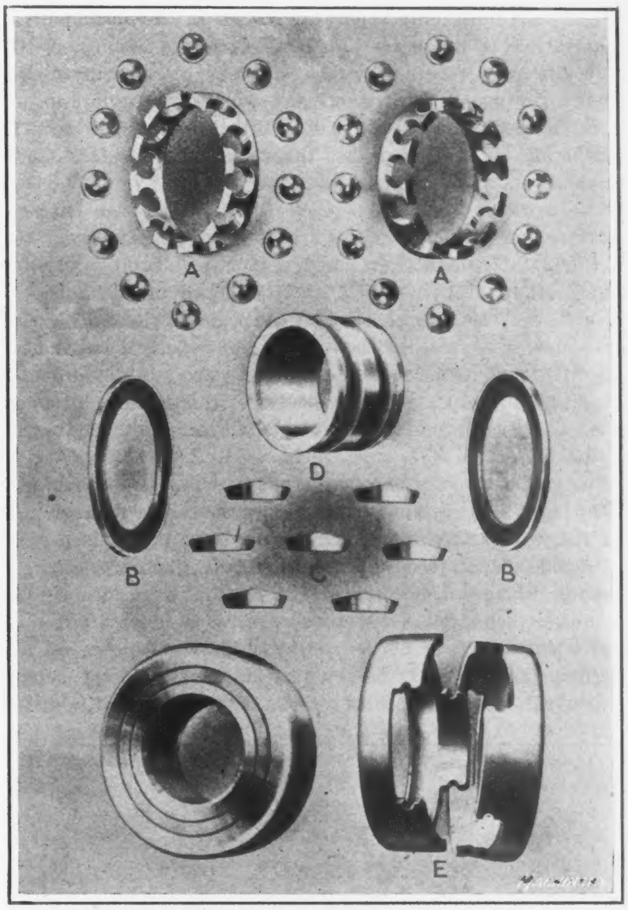


Fig. 4. Parts of Ball Bearing shown in Fig. 1

The self-adjusting feature is of considerable interest. As mentioned, it is obtained by making the ring between the two ball rows in two parts, as shown in Figs. 3 and 4. When these rings are placed back to back in the bearing, they just fit between the ball rows like a solid ring. The recess on the inner side of each ring section makes a space between the two sections when they are placed together, and in this recess are placed the springs already referred to, which are made of the proper strength for each size of bearing. These springs are not constantly compressed and expanded like automobile springs, but are simply placed between the rings to provide for a certain dead pressure. They have prac-

tically no movement, except that they provide for an automatic adjustment in the bearing, as required on account of the slight wear that will occur during a long period of use. The flanges on the edges of the two rings prevent the rings from being pressed together in such a manner as to place a load upon the springs greater than the original load when the bearing is first assembled; hence, these springs are not subject to any stresses that would break them, and may be considered as the most durable parts of the whole bearing.

The construction of this ball bearing is said to provide for a thrust capacity practically equal to the radial capacity of the bearing, and hence it becomes unnecessary to use oversize bearings for high thrust loads. Thrust or radial loads, separately or acting together, are claimed to be taken care of by this bearing at any speed with equal facility.

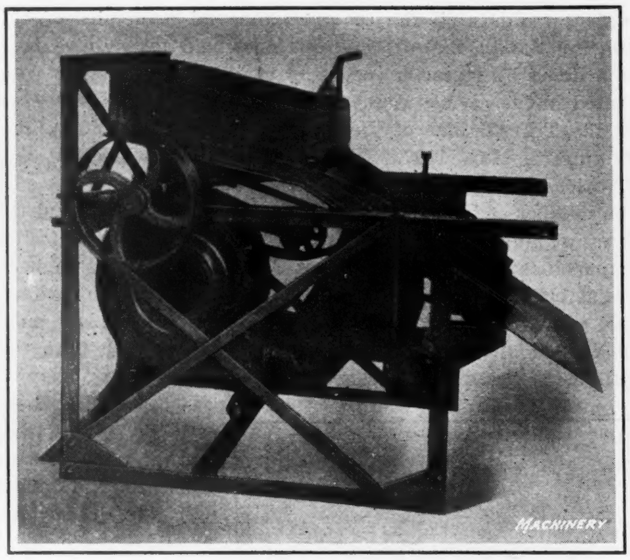
These bearings have been used with good results in grinding machine spindles, and have also been employed in woodworking machines where high speeds are necessary. As an evidence of durability, it is stated that bearings of this design have been in use in a wood carving machine spindle running at 8000 R.P.M. for over twenty months of continuous use, ten hours a day. These bearings are said to be still as good as new from an operative standpoint.

PNEUMATIC CHIP SEPARATOR

The pneumatic chip separator shown in the accompanying illustration is made by the Ideal Concrete Machinery Co., Colerain Ave., Cincinnati, Ohio, for use in separating chips from screw machine products and work of a similar nature. It is claimed that by the use of this machine one operator can handle as much work as three men using riddles, or as much as six men picking by hand.

The work and chips are placed in the hopper of the separator as they come from the machines. The hopper and the inclined slide which is attached to it, have a compound vibratory motion. When the gate at the front of the hopper is opened, the vibratory motion causes the work and chips to slide down over the inclined slide. A properly located opening in the slide permits the work to drop into a tote box or pan, while the chips are passed over the opening by means of an air draft from the fan so that they fall off the end of the slide.

The distinctive feature in the operation of this machine is as follows: The compound vibratory motion which spreads out the work and chips as they come down the slide permits a light air draft from the fan to float the chips over an opening in the slide through which the work drops; this method of separating the chips requires a much lighter air draft than would be needed if the chips were blown up into the air, and at the same time effects a satisfactory separation of chips from small as well as large work. In addition, the work does not at any time pass through enclosed passages, a feature which renders it practically impossible to clog the machine by overloading.



Pneumatic Chip Separator made by the Ideal Concrete Machinery Co.

The frame of the machine is constructed of angle iron, hot-riveted, and reinforced at the corners with heavy gusset plates. The bearings are lubricated by grease cups and sight-feed oil-cups.

GARDNER NO. 24 CONTINUOUS-FEED DISK GRINDER

The latest development of the Gardner Machine Co., 414 Gardner St., Beloit, Wis., is a continuous-feed disk grinder which is semi-automatic in operation, and designed to eliminate the unusual amount of labor expended in operating hand-operated disk grinders. Perhaps the most important feature of this machine is the constant production which is obtained from it. With any hand-operated machine, where the human element is the main factor in production, a uniform output all through the day cannot be obtained.

The machine carries one horizontal disk wheel 53 inches in diameter, and is provided with a revolving reel which carries four work-tables, as shown in Fig. 1. The work to be ground is attached to these tables by means of suitable fixtures mounted on them, and the revolving reel brings it over the surface of the grinding wheel. The tables are automatically lowered on the wheel. Pressure to insure quick removal of stock is secured through gravity, but by means of a compression spring this pressure may be adjusted. The weight of the table insures application of uniform pressure, which can be increased by adding extra weight if the character of the work necessitates it. A micrometer stop screw makes it possible to remove stock to definite dimensions.

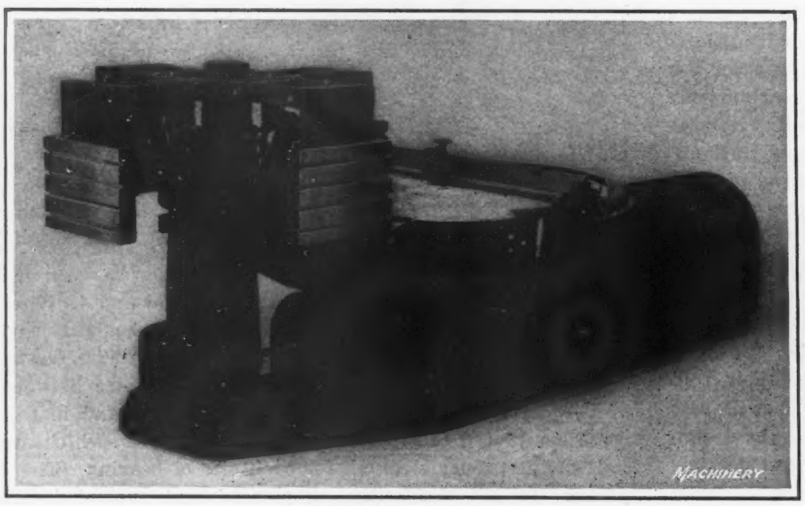


Fig. 1. Front View of Gardner No. 24 Continuous-feed Disk Grinder

Due to the construction just described, the operator simply places the work in the fixture and removes it when finished. (See Fig. 2.) The revolving reel is mounted on a vertical shaft 3½ inches in diameter, and is driven through worm, spur, and bevel gears from the gear driving the main spindle of the machine. By means of change-gears, the reel may be made to revolve ¼, ½ or 1 revolution per minute, thereby producing 1, 2, or 4 finished pieces per minute. Other speeds may be obtained by substituting special gears.

The driving shaft is provided with a friction clutch which is operated by a lever placed in a convenient position, which makes it possible to start or stop the feeding mechan-

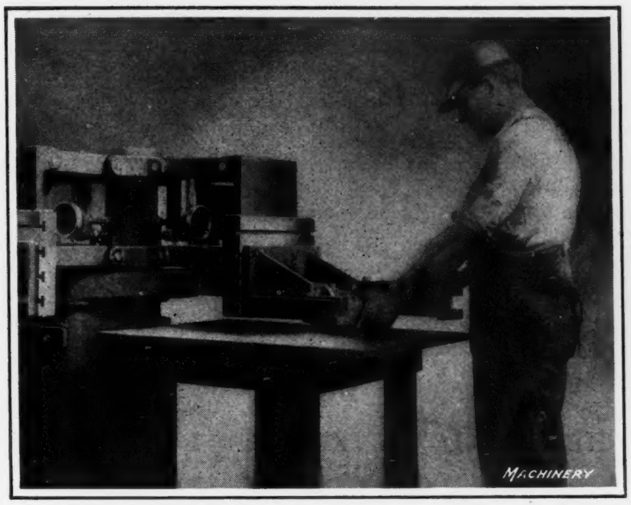


Fig. 2. Operator loads Machine by placing Work in Suitable Fixture carried on Work-table

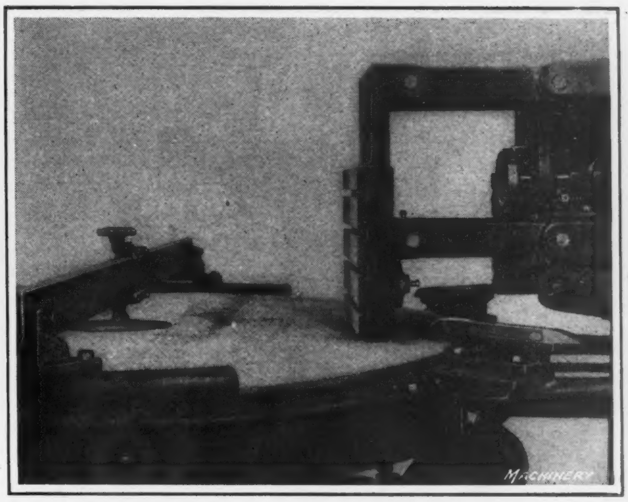


Fig. 3. Detail View of Table which is at Right Angles to Grinding Wheel, thus insuring Accurate Grinding

ism independently of the grinding wheel. The reel and the shaft which drives it are mounted in bronze bearings; all other shafts are carried in ball bearings. The gears are totally enclosed, which protects them from dust and dirt and allows them to be amply lubricated. The feeding stand is bolted directly to the baseplate upon which the machine is mounted, and to accommodate various sizes of work, has an adjustment of 6 inches along this baseplate. Because the work-tables are at right angles to the grinding wheel, accuracy of the work being ground is assured. (See Fig. 3.)

Rigidity and strength are important features of this machine. It weighs about 7600 pounds when crated for domestic shipment. The disk wheel is mounted on an extra large and heavy cast-iron flange. The driving spindle is of large diameter and runs in two self-aligning radial ball bearings. All down or end thrust is taken on a self-aligning ball thrust bearing which contains ten 1¼-inch diameter balls. Power is transmitted to the disk wheel by hardened special steel bevel gears. The ratio between the driving shaft gear and the spindle pinion is 2.4 to 1. These gears are also fully enclosed within the base of the machine, and provision is made for ample lubrication. They are completely protected from any grit or dust.

An extra pulley is mounted on the driving shaft for belting to an exhaust fan, which is set on the floor in back of machine. There is a dust channel cast into the base of the machine extending entirely around and underneath the outer edge of the disk wheel. When the guard ring is removed this channel is uncovered all the way around so that the grindings which might interfere with effective exhausting may be removed readily. A dust exhaust manifold is fastened into the bottom of this dust channel in four places and connected to an extra large exhauster, reducing the dust problem to a minimum. The cast-iron guard ring is fastened to the top of the base with collar head screws. Any portion of the guard ring is removable, permitting the grinding of work carrying a lug projecting above the plane of the ground surface.

This machine is adapted to a large variety of flat surface operations, such as crankcases; cylinder heads for automobiles, pumps and engines; transmission cases, valve chests, bearing boxes, steam chests and steam chest caps, pipe flanges, bearing caps; gear-cases, boxes and covers; hoisting machinery parts, stove parts, furnace parts, scale parts, etc.

RICKERT-SHAFER COLLAPSIBLE TAP

The Rickert-Shafer Co., 612 W. 12th St., Erie, Pa., has added to its line of threading machines and tools a new collapsible tap, which is shown in Fig. 1. The original and outstanding feature claimed for this tool is the method of withdrawing the chasers when the work is tapped to the required depth. The manufacturers claim that the tap is "positive acting" and cannot stick. This is a decided advantage in all cases of tapping, but will be found especially useful where work has to be tapped close to the bottom of the hole, as the chasers will be released at exactly the right point.

At the point of release the force of the cut pulls the head from the locking pins and revolves it. (See Fig. 2.) This action causes the cams on the core to act and pull the core back, drawing the chasers into the head and clearing them from the work. No dependence is placed upon springs for the purpose of collapsing. The method of making adjustments allows adjustments to be made to thousandths of an inch.

The Rickert-Shafer Co. guarantees that these taps will hold to size within the most exacting limits, and that sizing hand taps can absolutely be dispensed with when this collapsing tap is used. These taps have hardened and ground wearing parts, accurate chasers, and are chip-proof. They are manufactured in sizes from 1 to 10 inches, or larger, and can also be specially combined with boring, reaming, or chamfering tools, thus greatly increasing production by eliminating additional operations and set-ups.

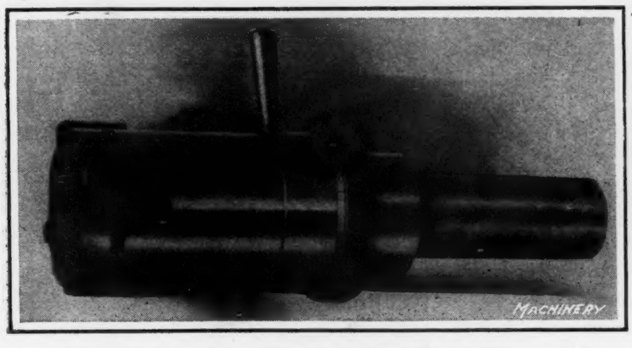


Fig. 1. Rickert-Shafer Collapsible Tap

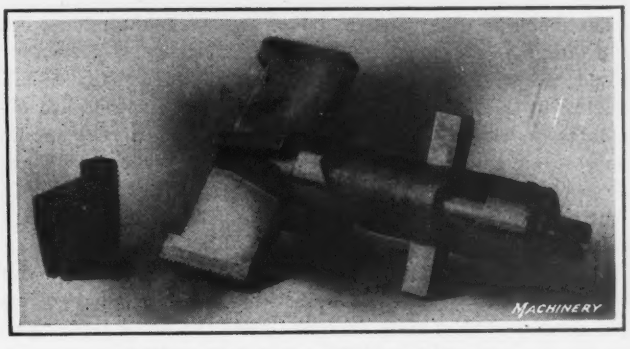
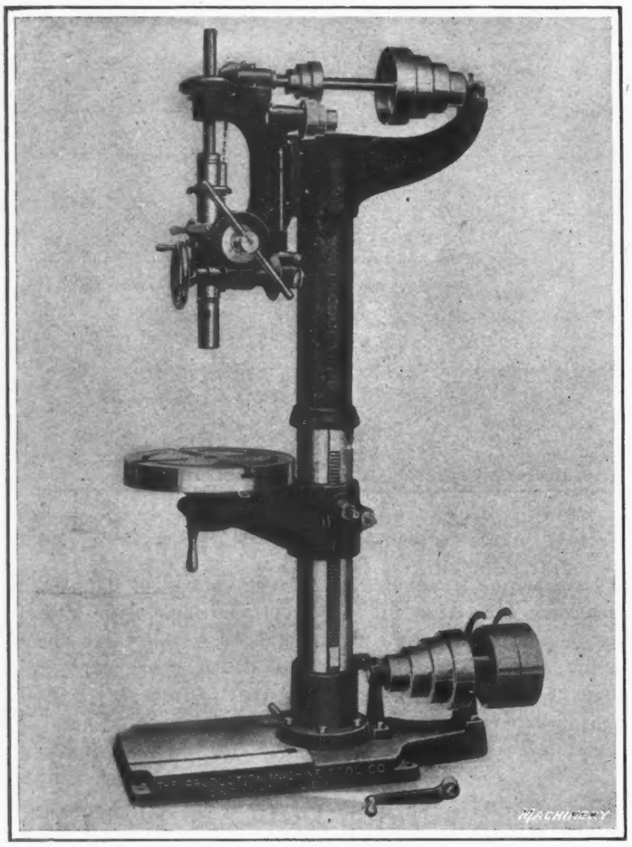


Fig. 2. Detail View of Rickert-Shafer Tap



Upright 22-inch Drilling Machine manufactured by the Production Machine Tool Co.

PRODUCTION DRILLING MACHINE

The twenty-two inch upright drilling machine illustrated herewith is now being manufactured by the Production Machine Tool Co., 629 E. Pearl St., Cincinnati, Ohio. This machine has a stationary head, power or hand feed, and a capacity for drilling, boring, and tapping holes up to and including 1¼ inches in diameter. All bearings are provided with bronze bushings. The base is of ample proportion and provided with T-slots. The column is of a tubular cross-section; it extends through the table arm and into the lower end of the over-arm, which is firmly bolted to it. The table arm is a casting of box construction and may be clamped in any position along the portion of the column on which it slides. It is also provided with a clamp for securing the table to it in any desired radial position.

As the table elevating worm and the table arm clamp are both on the right-hand side of the machine, the operator does not have to walk around the machine in order to lock the arm in place after the table has been set to the desired height. The over-arm provides sufficiently rigid support for mounting the motor on it when a direct motor drive is furnished with the machine. The over-arm is bored and fitted to the column. The head casting is also of box construction, and has the two spindle bearings cast integral, thus permitting both bearings to be bored and reamed at one setting and insuring an accurate alignment of the spindle.

The machine illustrated is driven from a countershaft, but if preferable, the machine may be driven by a geared or belted motor drive. The spindle is provided with a ball bearing to take care of thrust. Four spindle speeds are obtainable on the plain machine while four additional speeds are secured when back-gears are provided. The back-gears are of the sliding type; they are engaged by means of a positive clutch, and only revolve while being used. All gears and worms are covered with guards.

A trip is provided for automatically throwing out the power feed; and a positive clutch is used to disengage power-feed members when it is desired to use the hand feed. The spindle is counterbalanced by a weight enclosed in the column. The spindle sleeve is graduated a length of ten inches in sixteenths of an inch, permitting the automatic stop-collar to be set to throw out the power feed when the spindle has been lowered the desired depth.

Some of the principal dimensions of the machine are as follows: Distance from center of spindle to edge of column, 11 inches; minimum distance from spindle to base, 35 inches —maximum distance, 45 inches; minimum distance from spindle to table 9¾ inches—maximum distance, 25¾ inches. The spindle speeds obtainable with the back-gears in are 20, 33, 53, and 88 revolutions per minute; and with the back-gears out, 117, 196, 318, and 530 revolutions per minute. The power feeds per revolution of the spindle are 0.006, 0.010, and 0.015 inch per minute.

HAMMOND "NEVER-SLIP" PORTABLE CRANE

The Barrett-Cravens Co., 171 N. Ann St., Chicago, Ill., has recently brought out the Hammond "Never Slip" portable floor crane shown in the accompanying illustration. This crane is said to be the only machine of its kind on the market equipped with the worm and gear type of hoist. With this type of hoist the load can be raised to exactly the desired height, even to within a fraction of an inch. The load is automatically locked at all points of its travel, thereby assuring safety even when the hoist is used by a careless operator.

All-steel construction is employed, as experience has proved that iron castings will not stand up under the exceptionally heavy service required of a portable floor crane. The crane base and column are steel castings, and the hoisting device rests on the column arm. The wheels on which the crane is mounted are provided with chilled treads to insure good wearing qualities, while their webs are left soft to give strength. Hyatt roller bearings are used in all wheels so that heavy loads may be pulled easily. The hoisting mechanism consists of a worm-gear constructed of bronze, a screw cut from solid steel shafting, a steel sprocket designed with a wide factor of safety over the rated capacity, and an electrically welded chain intended to give the greatest strength with the least possible weight. The screw and worm are enclosed in an oil-tight housing to permit proper lubrication.

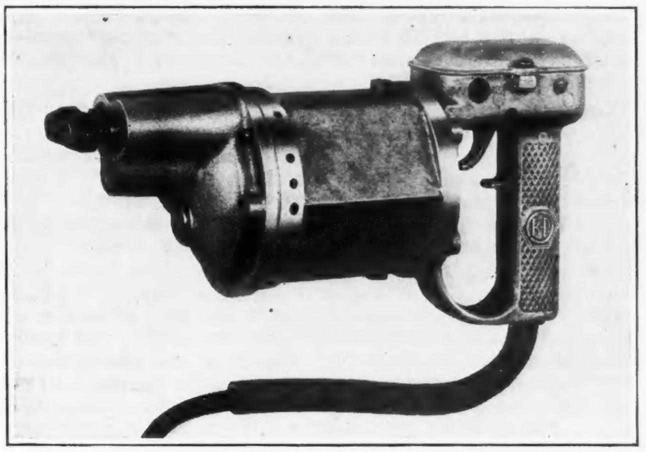
Hammond Portable Floor Crane

These cranes are made in six sizes. The smallest or No. 1 size has a lifting capacity of 2000 pounds; a total height of 6 feet; a lift of 4 feet 10 inches; an outside width of bed of 3 feet 6 inches; and an inside width of bed of 2 feet. The length of the bed is 3 feet, and the height 8 inches. The weight is 575 pounds. The largest or No. 6 size has a lifting capacity of 7000 pounds; a total height of 10 feet 8 inches; a lift of 8 feet 6 inches;

an overhang of 3 feet 8 inches; an outside width of bed of 4 feet 3 inches; and an inside width of bed of 3 feet 6 inches. The length of the bed is 4 feet 10 inches, and the height 12 inches. The total weight is 1400 pounds.

BLACK & DECKER TWO-SPINDLE DRILL

The Black & Decker Mfg. Co., of Towson Heights, Baltimore, Md., has recently designed a two-spindle drill. This particular design is specifically adapted for drilling holes for the Murphy top fastener, which is used for attaching automobile side curtains. When the base of the fastener is put on the automobile body, two holes 7/8 inch apart must be drilled, and this two-spindle drill drills the two holes the correct distance apart in the same operation.

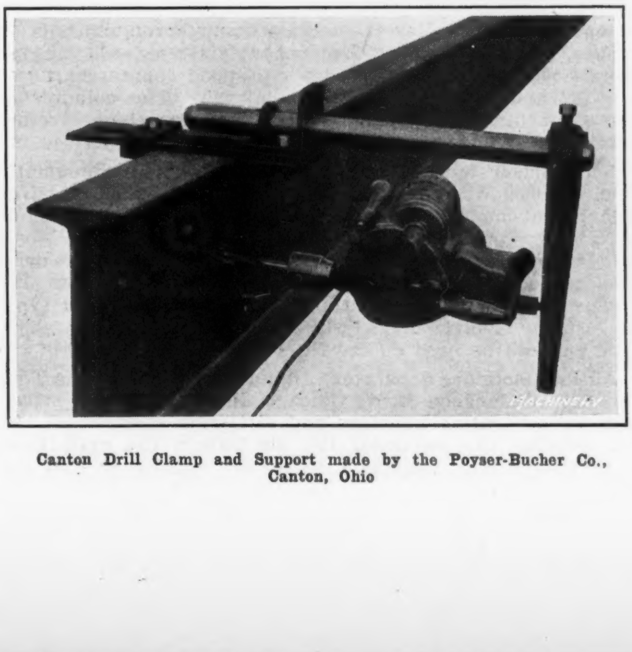


Black & Decker Two-spindle Drill

The handle of the drill is like that of an automatic pistol, and a pull on the trigger sets the two drill spindles in motion. A second pull stops the spindles, so that the operator can control the tool without changing the position of either hand. The gears for driving the two spindles are of steel, heat-treated. The two spindles have specially designed chucks.

CANTON DRILL CLAMP

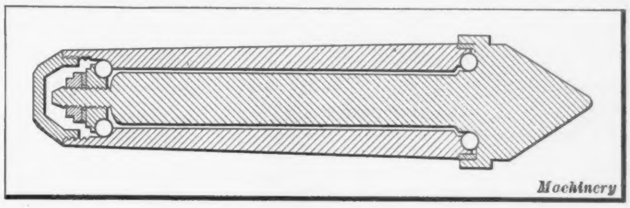
The Canton drill clamp and support shown in the accompanying illustration is made by the Poyser-Bucher Co., Canton, Ohio. This clamp is intended for use in drilling operations such as are generally performed on I-beams by the use of a "gooseneck" support or "old man." It is claimed that this new support enables the workman to drill sixteen holes in the time required for drilling one hole with the "old man" or "gooseneck" support. Referring to the illustration, it will be evident that with but one adjustment, any number of holes can be drilled in the top, bottom, or web of an I-beam.



Canton Drill Clamp and Support made by the Poyser-Bucher Co., Canton, Ohio

SNELLEX FRICTIONLESS CENTER

The center brought out by the Snellex Mfg. Co., Rochester, N. Y., is so constructed that the live center turns with the work on ball bearings. The arrangement of the bearings and general construction of the center is clearly shown by the



Sectional View of Snellex Center

accompanying sectional view. This center is designed to eliminate friction between the work and the center, to make it unnecessary to regrind centers, and to prevent worn or burned center holes in work. At the rear end of the center there is an adjustable cone for the bearings, together with a lock washer and check-nut, and the end is sealed by an oil-cap. The ball races are at an angle of 45 degrees, and it is claimed that as the result of a "spiral motion" the balls are kept round and uniform in size, thus insuring permanent accuracy of the center. These centers are made in four sizes, varying from No. 1 to No. 4 Morse taper.

BADGER VERTICAL-SPINDLE DISK GRINDER

A vertical-spindle disk grinder known as the No. 142 has recently been added to the line of equipment manufactured by the Badger Tool Co., Beloit, Wis. The grinding wheel provided on this machine is a disk 42 inches in diameter

Badger No. 142 Motor-driven Disk Grinder

which revolves in a horizontal plane at the speed of 600 revolutions per minute. The work to be ground is placed on top of the disk, suitable cross-bars or stops being furnished to prevent the work from rotating with the wheel. The weight of the work itself, or auxiliary weights provided, exerts sufficient pressure against the disk to cause the work to be ground.

A dust channel completely surrounds the outside of the wheel, this channel being accessible by removing the top guard ring. The grinder is driven by a fifteen-horsepower vertical motor provided with forced ventilation and being arranged for effective lubrication and dust exhaust. The spindle is mounted in radial and thrust ball bearings. The

thrust bearing is placed adjacent to the wheel collar, the latter being 11 inches in diameter and 1½ inches thick.

This disk grinder is only built in the motor-driven type; this construction requires small floor space and permits the machine to be operated from any position, there being no obstructions to interfere with a man working at any point around its periphery. The complete equipment includes a 42-inch diameter steel disk wheel, dust exhaust system, improved type of wheel press, oil compensator, and an assortment of abrasive disks and other supplies. The total weight of the machine is 3000 pounds.

NEW MACHINERY AND TOOLS NOTES

Riveter: Baird Pneumatic Tool Co., Kansas City, Mo. The Baird "Close-corner" riveter intended for use in close corners where riveting by a hand hammer is impossible. A pressure of 50 tons is exerted on the dies, and 5/16-inch rivets can be driven cold.

Truck Body: Karry-Lode Industrial Truck Co., Inc., 98-100 Nott Ave., Long Island City, N. Y. An all-steel dumping body having a capacity of 40 cubic feet, designed for use on the trucks of this company's manufacture. The body is dumped over the end of the truck, and is especially adapted for handling coal.

Transveyor Truck: Cowan Truck Co., 16 Water St., Holyoke, Mass. Improvements on the Cowan Type G transveyors, which enable them to be used as trailers behind electric storage battery trucks, either singly or in trains. With this arrangement a train of ten trucks can be turned in a circle on a twenty foot roadway.

Riveter: Baird Pneumatic Tool Co., Kansas City, Mo. A riveter designed for riveting ash cans, which is mounted on a stand and provided with a foot-operated controlling valve, leaving the workman's hands free for holding and locating the work. A pressure of 35 tons is exerted on the dies with an air pressure of 100 pounds per square inch.

Staybolt Chuck: Tom Brown & Co., 800 Great Northern Bldg., Chicago, Ill. The "Perfection" reversible staybolt chuck manufactured by the Lovejoy Tool Works. This chuck grips either threaded or blank round staybolts, and thus eliminates the necessity for squaring the ends. It is made in three sizes, to fit bolts from ¾ to 1½ inches.

Friction Clutch: A. Mill Clutch Co., 2116-2120 Colerain Ave., Cincinnai, Ohio. A clutch known as the Mill duplex friction clutch, designed to facilitate smooth engagement or disengagement at high speeds. Friction contact is made first by an expansion ring and then by side plates. The friction members are enclosed in a dustproof case.

Counterbores and Spot-facers: Dayton Machine Products Co., Dayton, Ohio. "Duplex" interchangeable counterbores and spot-facers, consisting of four parts—holder, cutter, collet, and locking screw. Cutters from ⅝ to 3 inches in diameter can be furnished. Morse taper shanks Nos. 1 to 6 are standard, but straight-shank holders can also be supplied.

Furnace: Industrial Electric Furnace Co., 53 W. Jackson Blvd., Chicago, Ill. An electric melting and refining furnace operated directly on a 220-volt motor circuit without transformers. The builders claim that this furnace can be used by an operator having practically no electrical knowledge. It is built with capacities of from 300 pounds to 1½ tons per heat.

Platform Truck: Terminal Engineering Co., Inc., 17 W. 44th St., New York City. An industrial platform truck having a rated capacity of 5000 pounds, a rated speed of from ½ to 10 miles per hour light, and of ½ to 7 miles per hour under full load. The driving and elevating motors are 60-volt, series-wound. A motor is provided for each wheel, making the drive of the four-wheel type.

Trip for Power Press: Tom Brown & Co., 800 Great Northern Bldg., Chicago, Ill. The "Perfection" pneumatic trip for power presses made by the Lovejoy Tool Works. This device is attached to the side of the machine and can be operated by pulling a cord, thus permitting the workman to operate the trip when balancing a plate in the press of such size that the hand trip is beyond his reach.

Reamer-holder: Scully-Jones & Co., 647 Railway Exchange Bldg., Chicago, Ill. A floating reamer-holder, designed for holding reamers in turret lathes, and for similar work where it is important that the reamer be permitted to float freely in its axis of rotation. These holders are furnished with a shank to fit any size of turret lathe or with any size of taper shank to fit drilling machine or lathe spindles.

Babbitting Fixture: O. A. Bremer Co., 222 Division St., Burlington, Iowa. A babbitting fixture intended for garage repair work, which has a capacity for rebabbitting connecting-rods up to 12 inches in length and of any bore from ½ to 2½ inches. A special fixture is also made for rebabbitting Ford connecting-rods. It is claimed that very little scraping is required to obtain a perfect fit when these fixtures are employed.

Electric Motor: Hobart Bros. Co., Troy, Ohio. A line of electric motors ranging from 1 to 10 horsepower. The motors have ball bearings and are furnished with base tracks and pulleys. All motors have a speed of 1800 revolutions per minute. The alternating-current motors can be furnished in either two or three phase and practically any cycle and voltage, and the direct-current motors can be furnished in any voltage.

Press: Toledo Machine & Tool Co., Toledo, Ohio. A straight-column inclinable press known as the No. 54 "Special," having direct motor drive, with the motor so mounted that it is always in a vertical position and the pinion always in mesh. The bed is 23 by 24 inches; the opening in the bed 12 by 12 inches; the distance between housings 24 inches; and the stroke, 2 inches. The weight is 6500 pounds.

Engraving-cutter Grinding Machine: George Gorton Machine Co., Racine, Wis. A machine for grinding the cutters used on engraving machines of this company's manufacture. The abrasive wheel is driven direct by a motor incorporated in the machine. An indexing sleeve and graduated base enable the tool to be held in identically the same way as it is held in the engraving machine, or at any desired angle while grinding.

Rivet-cutting Tool: Keller Pneumatic Tool Co., Grand Haven, Mich. An air-operated tool designed for cutting off and backing out steel rivets, which is known as the Keller "Iron Mule rivet-buster." The length of the tool over all is 67 inches, and its operating weight is 82 pounds. Three men are needed to operate the tool to the best advantage. Rivet heads ⅞ and 1 inch in diameter can be cut off in from four to six blows.

Cutting Torch: Torchweld Equipment Co., Fulton and Carpenter Sts., Chicago, Ill. A Style 15 MC gas cutting torch, designed to use oxy-acetylene, oxy-hydrogen, or oxy-hydrocarbon gases, when equipped with special tips. The standard torch-head angle is 85 degrees but 70-, 50-, and 35-degree as well as straight heads can be furnished when desired. A special device is employed to blow out back-fires and eliminate the hazard of flash-backs.

Soldering Iron: Made by Peterson-Plummer Mfg. Co. and sold through Belfrey & Craighead, Tribune Bldg., Chicago, Ill. A light-weight soldering iron known as the "Ever-hot," having the gasoline reservoir contained in the handle. The pump unit is placed at the end of the handle, and is easily removed for refilling. The one-piece burner is arranged to preheat the gas, and its design permits the iron to be used in any position in extremely cold weather and high winds.

Grinding Machine: Wisconsin Electric Co., 2529 16th St., Racine, Wis. An electric grinding machine known as the "Dumore No. 3 Multi-speed," which is suitable for both production and tool-room work. A set of interchangeable spindles adapts the machine for both internal and external grinding operations. The ¼-horsepower universal motor is furnished for either alternating or direct current. Seven spindle speeds ranging from 3600 to 50,000 revolutions per minute are available.

Milling Machine: American Milling Machine Co., Cincinnati, Ohio. Improvements on the No. 1½ plain and universal milling machines of this company's manufacture, including a four-step cone pulley the largest diameter of which is 11 inches, and the smallest, 7⅝ inches; sixteen feeds ranging from 0.005 to 0.212 inch; and a two-speed countershaft giving 107 and 265 revolutions per minute. The columns of these machines are drilled and tapped for the swiveling vertical milling attachment made by this company.

Screwdriver for Portable Drill: Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill. A screwdriver attachment made in three styles to fit the different types of portable motors of this company's manufacture. The No. 1 attachment is designed for the "Thor" turbine air drill, and has a capacity for handling No. 12 wood-screws 1¾ inches long. The No. 2 attachment is an extension type, for use on electric drills, while the No. 3 is of the short type and can be used on the No. 00 "Thor" electric drill.

Air-line Moisture Separator: Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill. The "Thor" separator for separating moisture and dirt from compressed air. On entering the separator the air strikes the cylindrical walls tangentially, causing it to revolve rapidly, so that the

centrifugal force throws the entrained moisture and dirt to the walls where they descend to the bottom of the tank, while the clean air passes on to the pipe line. The separator is built in two sizes having capacities of 150 and 400 cubic feet per minute.

Grinding Wheel Dresser: Commercial Welding & Machine Co., Worcester, Mass. Three styles of grinding wheel dressers using conical cutters. Two styles are made in 2- and 2½- inch sizes with a standard length of 6 inches, one being provided with a double ball bearing at the front end and a ball radial and thrust bearing at the rear, and the other with roller bearings and a ball thrust bearing. A third type has a spindle that runs in soft bushings, and is designed to carry a ⅞-inch conical cutter suitable for dressing small cup and cylinder wheels.

Portable Grinder: Roto Pneumatic Co., 4700 Train Ave., Cleveland, Ohio. A portable rotary pneumatic grinder having only three moving parts, consisting of the pistons, which are rigidly mounted on a straight shaft (thus constituting a single rotating member) and two self-sealing sliding valves. From 15 to 20 cubic feet of air per minute under a pressure of 80 pounds per square inch entering the machine through the control handle is required to operate the grinder. The machine weighs 40 pounds, and swings either a 6-inch or an 8-inch wheel.

Motor Starter: Cutler-Hammer Mfg. Co., 12th nd St. Paul Aves., Milwaukee, Wis. The time-limit automatic starters of this company's manufacture have been redesigned to include both larger and smaller sizes. An air dashpot can now be supplied in place of the oil dashpot when desired. After once being set, the starter will cut out the resister in the required length of time, when controlled from any remote point by a single pole knife switch, a vacuum regulator float switch, or by a three-wire push-button control. The new starters are made in capacities of from ¼ to 10 horsepower at 115 volts, and up to 25 horsepower at 230 and 500 volts.

Hydraulic Presses: Southwark Foundry & Machine Co., 430 Washington Ave., Philadelphia, Pa. Three types of hydraulic presses. A 20-ton hydraulic broaching press having a clearance between the columns of 20 inches, a speed of from 15 to 20 working strokes per minute, and an accumulator designed to operate at a pressure of 1500 pounds per square inch. A 200-ton hydraulic bushing press, especially intended for use in railroad shops, and having a ram 12 inches in diameter operated at a hydraulic pressure of 3500 pounds per square inch. This press has a clear distance between columns of 32¾ inches, and an 8-inch slot is provided in the intermediate platen to accommodate piston-rods. A 200-ton hydraulic upsetting press adaptable to general upsetting work but especially suitable for upsetting the flanges on automobile crankshafts. This press has a vertical ram which carries a die that can be moved down to surround the heated work located on the anvil, and a horizontal ram which can then be run forward to upset the work.

* * *

FIGHTING TUBERCULOSIS IN THE INDUSTRIES

It is stated on the authority of the National Tuberculosis Association that out of every one hundred people employed in the average factory and manufacturing plant, two have tuberculosis in some form or other. It has been pointed out that the loss to the industries due to neglect in preventing the spread of this disease is very large. Just as the industries have taken steps to prevent accidents in their shops, not only from a humanitarian motive, but also as a means of increasing industrial efficiency, so the industries should take steps to control tuberculosis by careful medical supervision.

The prevention of tuberculosis in industry requires these steps: First, a medical examination of every applicant; second, periodic medical examination of all employes, and special examination of those who are found to be ailing in any respect; third, medical supervision and care for every employe that needs any attention; fourth, education of employes on the control of preventable diseases and their personal responsibility to the problem. If these things are done, any employer can aid in stopping waste in industry. That it pays to do this is evidenced, for example, by the work done by such concerns as the International Harvester Co., the National Cash Register Co., and many others. Tuberculosis can be reduced to a practical minimum in industry, and the saving in dollars and cents will pay the largest possible dividends on the money expended in this work. The National Tuberculosis Association, 381 Fourth Ave., New York City, and its allied agencies stand ready to help any employer in solving the problem of tuberculosis in industry.

E. P. BULLARD, JR., AWARDED FRANKLIN INSTITUTE MEDAL

The Howard N. Potts medal, which is awarded for distinguished work in science and mechanical arts by the Franklin Institute, was presented, October 20, to E. P. Bullard, Jr., president of the Bullard Machine Tool Co., Bridgeport, Conn., for his work in connection with the development of automatic machinery in the metal-cutting field. As is well known, the Bullard mult-au-matic is used with great success in the automobile and allied industries, where rapid production of duplicate parts made in great quantities becomes of first importance. The installation of more than 100 Bullard mult-au-matics at the Ford plant in Detroit was described in the December, 1919, number of MACHINERY, together with a review of the work done on the machines.

The mult-au-matic machine marked a new departure in the development of automatic machinery, and it is in recognition of the pioneer work in this field done by Mr. Bullard that the Franklin Institute has accorded to him a fitting tribute. In view of the important part that machine tools in general and automatic metal-working machinery in particular play in our whole industrial development, it is gratifying that a man in this field is receiving so well deserved a tribute.

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INDUSTRIAL COST ASSOCIATION

The Industrial Cost Association is an organization composed of industrial executives who use cost information and who control the cost policies of corporations, firms, and trade associations. The association is working toward the improvement of cost accounting in industry. The object is to standardize the governing principles and the terminology of costs as applied to industrial undertakings. A committee for uniformity of accounting will be appointed to assist committees of trade associations in standardizing cost methods. It is planned to organize sections in various localities where there are members of the association. M. F. Simmons of the General Electric Co., Schenectady, N. Y., is president, and A. A. Alles, Jr., Fawcus Machine Co., Pittsburg, Pa., is secretary of the association.

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MANUFACTURER OF COLLAPSIBLE TAP

We have been informed that the collapsible tap described in the article on "Shop Practice in an Axle Plant," beginning on page 166 of the October number of MACHINERY and shown in the illustration Fig. 1, as well as the boring and reaming tools mentioned, were especially designed for the Timken-Detroit Axle Co. by the Murchey Machine & Tool Co., Detroit, Mich.

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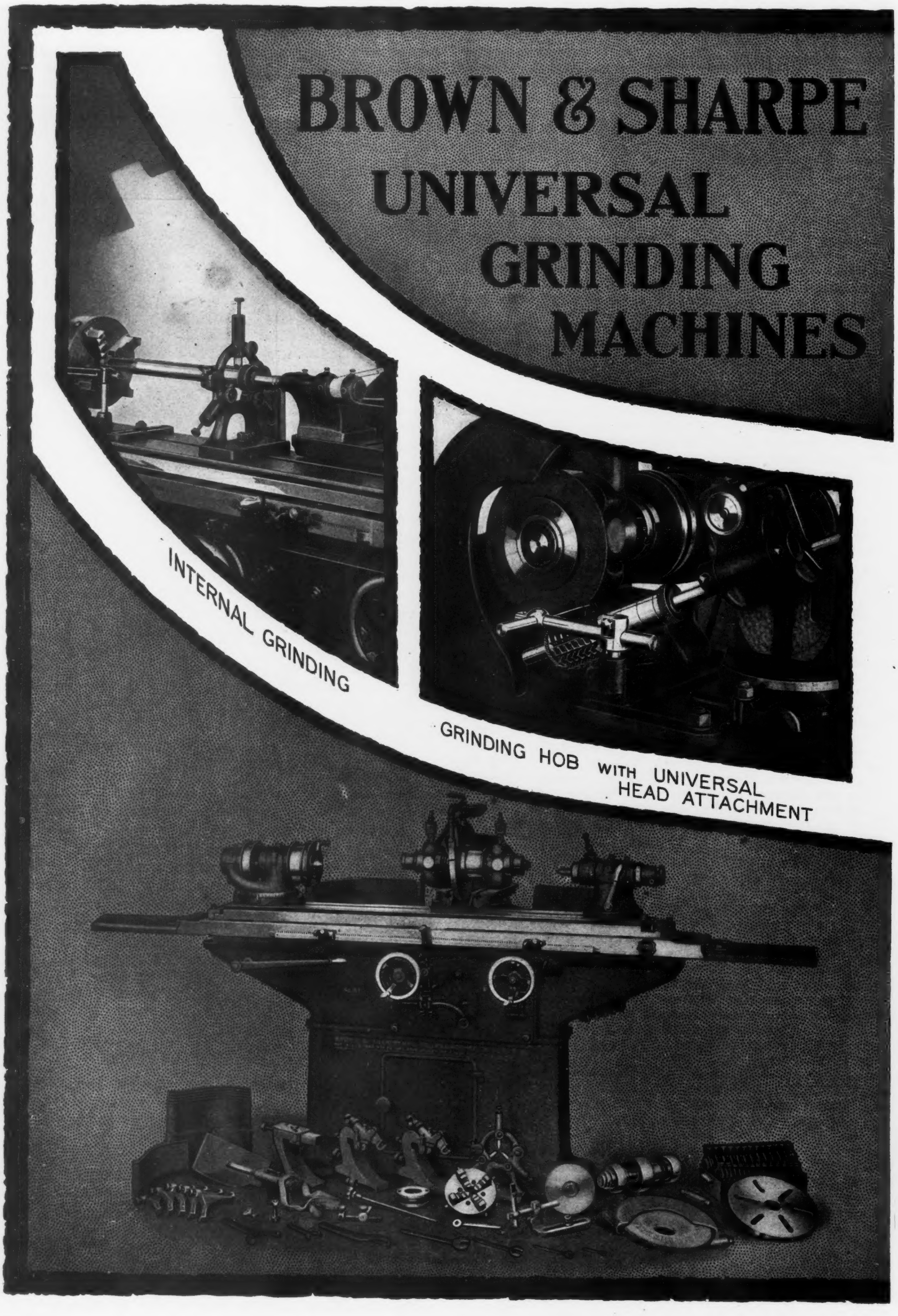
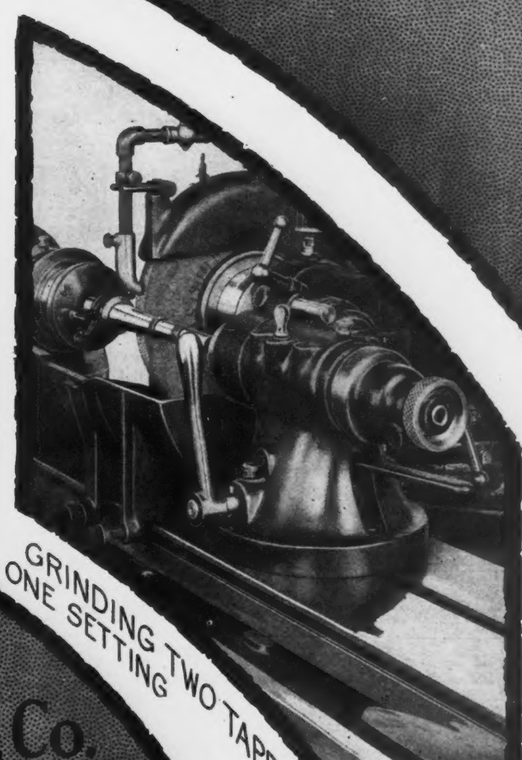
Statistics show that about 13 per cent more pig iron was produced in the first half of this year than in the corresponding period of 1919. The production this year was about 18,400,000 tons, whereas in 1919 it was 16,300,000 tons. The production of malleable pig iron showed an increase of 43 per cent.


BROWN & SHARPE
UNIVERSAL
GRINDING
MACHINES
INTERNAL GRINDING
GRINDING HOB WITH UNIVERSAL
HEAD ATTACHMENT

ADAPTION TO DISC GRINDING



GRINDING TWO TAPERS AT ONE SETTING

PERSONALS

C. C. Gray, formerly with the Farrar Advertising Co., has become manager of sales for Pannier Bros. Stamp Co., Pittsburg, Pa.

F. Rodger Imhoff, who has been located permanently in Detroit as field engineer for the Precision & Thread Grinder Mfg. Co., Philadelphia, Pa., has been appointed sales manager.

G. J. Keller, formerly district manager of the Buffalo office of the Knox-Anderson Tool Co., has become sales manager for the Frontier Chuck & Tool Co., Inc., 30 Letchworth St., Buffalo, N. Y.

Edward Grossman, who was recently appointed sales manager of the T. P. Walls Tool & Supply Co., Inc., 25 Leonard St., New York City, has been made treasurer and manager of the company.

A. J. Baker, formerly chief engineer of the Cincinnati Milling Machine Co., who recently became research engineer of the Willys-Overland Co., Toledo, Ohio, sailed for England on October 16, for a three-months' trip.

Fred E. Kelly, for four years sales engineer for M. Jaeger, dealer in small tools, Engineers Bldg., Cleveland, Ohio, has entered the employ of the Cowles Tool Co., Cleveland, for whom he will act as sales representative.

W. B. Currier, Jr., has been appointed general manager of the Cleveland Planer Co., and of the Cleveland Machine Tool Co., Cleveland, Ohio, succeeding D. B. Clark who will now devote his entire time to the Clark-Mesker Co., of Cleveland.

J. G. Moohl, formerly chief engineer of the Cleveland Machine Tool Co., Cleveland, Ohio, has been appointed sales manager of that company, and also of the Cleveland Planer Co. He will have charge of the engineering and sales departments of both companies.

A. A. Loeffler has recently been appointed Detroit representative of the Doehler Die-Casting Co., Court, Ninth, and Huntington Sts., Brooklyn, N. Y., succeeding F. C. Seeger who will represent the company on the Pacific coast, with headquarters in San Francisco.

T. J. Davis, formerly representing the Union Twist Drill Co. of Athol, Mass., in Michigan, Illinois, Indiana, Wisconsin, and Minnesota, has become connected with the W. L. Romaine Machinery Co., Milwaukee, Wis., as manager of the tool and equipment department.

Brent A. Tozzer, formerly in charge of the Cleveland office of the Niles-Bement-Pond Co., has sailed from San Francisco for a one-year's business trip in the interest of the Niles-Bement-Pond Co., during which trip he will visit India, China, Japan, and other Far Eastern countries.

Edward Casey has joined the Duff Mfg. Co., Pittsburg, Pa., manufacturer of all types of lifting jacks, as sales representative of the forge department in the east, with offices at 50 Church St., New York City. Mr. Casey was formerly associated with Kraenter & Co., and the Bethlehem Steel Co.

R. G. Berrington, for fifteen years with the Cleveland Twist Drill Co. and prior to that with the Strong, Carlisle & Hammond Co. of Cleveland, is now Cleveland sales manager for the Reed-Prentice Co., Becker Milling Machine Co. and Whitcomb-Blaisdell Machine Tool Co., with office and stock warehouse at 408 Frankfort Ave., Cleveland.

George B. Hodges has been appointed manager of the industrial and production department of the McVicker Engineering Co., 716 Metropolitan Life Building, Minneapolis, Minn. Mr. Hodges has been identified with production and industrial work on tractors, plows, and power farming machinery for the last eighteen years.

W. E. Seymour, for six years works manager of Fairbanks, Morse & Co., Beloit, Wis., and recently vice-president and general manager of the A. O. Smith Corporation, Milwaukee, Wis., has organized the W. E. Seymour Mfg. Corporation in Milwaukee, to manufacture piston rings and motor parts. Mr. Seymour will serve as president of the company.

George B. Morris has opened offices at 803 Security Bldg., Los Angeles, Cal., specializing in the selling of hoisting and conveying machinery on the Pacific Coast. Mr. Morris has the exclusive representation in California for the Shepard Electric Crane & Hoist Co. of Montour Falls, N. Y., and is looking for other non-competing products in the material-moving lines.

H. M. Houston, who was recently connected with the Houston, Stanwood & Gamble Co., has taken up executive duties as an active member of the William K. Stamets Co., Pittsburg, Pa., manufacturer of machine tools. Mr. Houston has been in close touch with the Samets organization for a number of years, and is therefore somewhat familiar with his new duties.

Thomas J. Moore, for ten years resident sales manager of the Halcomb Steel Co., Philadelphia, Pa., has organized a new company known as the Rupp Moore Co., Inc., at 1418 Walnut St., Philadelphia. The company will do business in tool and alloy steel; crucible, electric, and open-hearth bars; and billets and forgings. Mr. Moore is president of the new company and Robert Rupp is secretary and treasurer.

E. W. Bernhard has been placed in charge of manufacturing in the plants of the L. H. Gilmer Co., manufacturer of solid woven belting and automotive products, the home offices of which are in Tacoma, Philadelphia, Pa. Mr. Bernhard was connected with the S. K. F. Industries Co., for seven years, serving as assistant general factory manager of the organizations under S. K. F. control. He will have charge of the two Gilmer plants in Philadelphia, and the plant in North Wales, Pa., and the mill at Millen, Ga.

R. A. Bull, formerly vice-president of the Duquesne Steel Foundry Co., Pittsburg, Pa., has been appointed consulting metallurgist for a number of prominent steel foundries which have been grouped for the purpose of developing and perfecting higher standards in the production of steel castings. Among this group of foundries are the following: Electric Steel Co., Chicago, Ill.; Fort Pitt Steel Castings Co., McKeesport, Pa.; Isaac G. Johnson Co., Spuyten Duyvel, N. Y.; Lebanon Steel Foundry Co., Philadelphia, Pa.; Michigan Steel Castings Co., Detroit, Mich.; and Sivyer Steel Castings Co., Milwaukee, Wis. Mr. Bull will devote his entire time to preliminary research work.

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CHANGE IN DATE OF NATIONAL MACHINE TOOL BUILDERS' CONVENTION

Announcement has been made of a change in date of the National Machine Tool Builders' convention to be held in New York City. The convention will be held on November 11-12, instead of December 2-3 as previously announced.

COMING EVENTS

November 10-12—National fall convention of the Society of Industrial Engineers at the Carnegie Music Hall, Pittsburg, Pa. Business manager, George C. Dent, 327 S. La Salle St., Chicago, Ill.

November 11-12—Nineteenth annual convention of the National Machine Tool Builders' Association in New York City; headquarters, Hotel Astor. General Manager, Charles E. Hildreth, Worcester, Mass.

November 17-18—Twenty-fourth annual convention of the National Founders' Association, at the Hotel Astor, New York City.

November 18-20—Meeting of the Federated American Engineering Societies at the New Willard Hotel, Washington, D. C. Headquarters, Engineering Societies Bldg., 29 W. 39th St., New York City.

December 7-10—Annual meeting of the American Society of Mechanical Engineers at 29 W. 39th St., New York City.

January 11-13—Annual meeting of the Society of Automotive Engineers in New York City. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

NEW BOOKS AND PAMPHLETS

The Effect of Addition Agents in Flotation. (Part II). By M. H. Thornberry and H. T. Mann. 68 pages, 6 by 9 inches. Published by the School of Mines and Metallurgy of the University of Missouri, Rolla, Mo.

Bituminous Coal Storage Practice. By H. H. Stoek, C. W. Hippard, and W. D. Langtry. 157 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 116 of the Engineering Experiment Station. Price, 90 cents.

Measurements on the Thermal Dilatation of Glass at High Temperatures. By C. G. Peters and C. H. Cragoe. 39 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper No. 393 of the Bureau of Standards.

Blueprint Reading. By E. M. Wyatt. 86 pages, 6 by 9 inches. Published by the Bruce Publishing Co , Milwaukee, Wis. Price, $1; by mail $1.10.

This book is the result of the author's experience in teaching blueprint reading in night schools for several years, and of several years' experience in teaching drafting. It is not intended for those who need an expert knowledge of mechanical drawing, but is prepared with the idea of giving an understanding of the fundamental principles of mechanical drawing, a knowledge of drafting conventions, practice in interpreting drawings, and some practice in shop sketching, by means of which the student can express his own ideas. A number of drawings have been included to give practice in reading, and at the end of each chapter is a list of questions intended to stimulate the study of the drawings. An idea of the range covered can be obtained from the following chapter heads: Kinds of Drawings; Theory of Orthographic Projection; Meaning of Various Kinds of Lines; Foreshortened Lines, Inclined Surfaces, Auxiliary Projections; Scale Drawing, Dimensions; Breaks, Representing Drawings as Broken; Sections; Bolts, Screw Threads, Machining or Finish; Rivets—Structural Steel; Architectural Conventions; Study of a Set of House Plans; Study of the Bench Grinder.

High Frequency Apparatus. By Thomas Stanley Curtis. 270 pages, 5 by 7½ inches. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $3.

This is the second revised and enlarged edition of this work. The aim has been to make the treatment essentially practical and to avoid purely theoretical material as much as possible so as not to confuse the non-technical reader.

The designs presented are the result of actual construction and experiment. The book is divided into six basic parts: The first two chapters explain what the high frequency current is, what it is used for, and how it is produced; the second section, comprising four chapters, describes in detail the principles of the transformer, condenser, spark gap, and oscillation transformer, and covers the main points in the design and construction of these devices as applied to the work in hand; the third section covers the construction of small high frequency outfits designed for experimental work in the home laboratory or in the classroom; the fourth section is devoted to electro-therapeutics and X-ray apparatus; the fifth section describes apparatus for the cultivation of plants and vegetables; and the sixth section is devoted to a discussion of apparatus of large size for use on the stage in spectacular productions. The closing chapter gives current prices of the parts and materials required for the construction of the apparatus described.

The Locomotive up to Date. By Charles McShane. 893 pages, 6 by 9 inches; 378 illustrations. Published by Griffin & Winters, New York Life Bldg., Chicago, Ill. Price, $5.

An entirely new edition of this book has been prepared covering the field of modern locomotive construction, repair, and operation. Everything in the former edition has been carefully checked with modern practice, and a great amount of new material is now presented for the first time. The book is fully illustrated to make the text as clear as possible. Special articles have been prepared by the American Locomotive Co., Baldwin Locomotive Works, and the Westinghouse Air Brake Co. The description of all new devices has been prepared by the inventors themselves. The subjects treated are as follows: Locomotive Valves; Valve Gears; Valve Setting; Air Brakes; Accidents to Locomotives; Blows and Pounds; Locomotive Power Reverse Gears; Boilers; the Locomotive Mechanical Stoker; Superheat; Feedwater Heating; Boiler Fittings; Locomotive Injectors; Locomotive Lubricators; Safety Pop Valves; Steam Gages, Water Gages, and Gage Cocks; Steam Engine Indicators; Metallic Packing; Compound Locomotives; Oil Burning Locomotives; Electric Locomotives; Compressed Air Locomotives; Gasoline Locomotives; Shoes and Wedges; General Shop Work; Machine Shop Practice. An index of twenty-two pages, with cross references, should enable the reader to find any information without trouble or loss of time.

The Modern Electroplater. By Kenneth M. Coggeshall. 276 pages, 5 by 7½ inches; 142 illustrations. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $3.

Electroplating and allied processes are discussed in this book from a practical rather than from a scientific point of view. An attempt has been made to describe the equipment and to explain the practical methods of modern electroplating in the simplest possible terms. No material has been included which does not bear directly upon the subject of electro-deposition; for example, only the essential fundamentals of magnetism, electricity, and chemistry have been considered. An elementary outline of electricity and chemistry in relation to plating is given, which is followed by a description of shop layout and equipment. Full instructions are included for the preparation and finishing of the work, and formulas and complete directions are given for making all kinds of plating solutions, many of which are said to have been trade secrets until published in this book. The material is divided into ten chapters headed as follows: The Advance of the Electroplating Industry; Elementary Chemistry and Electricity; the Location and Construction of the Plating Room; Electrical Equipment for the Plating Room; Electroplating Tank Equipment; Miscellaneous Plating Room Equipment; the Preparation of Work for Electroplating; Plating Solutions and the Electro-deposition of Metals; Polishing, Buffing, and Lacquering; Useful Reference Data.

American Lubricants. By L. B. Lockhart. 341 pages, 6 by 9 inches. Published by the Chemical Publishing Co., Easton, Pa. Price, $4.

This is the second edition of this book, and the material contained therein has been revised and enlarged. The purpose of the book is to aid the user and the buyer of lubricants in making an intelligent selection of oils and greases. The point of view throughout is that of the user rather than that of the refiner. An effort has been made to include such facts and figures in regard to lubricants as will best bridge the gap between the refiner or manufacturer and the consumer, and on the other hand, to exclude irrelevant matter so as not to obscure the main facts. The book is divided into thirty-seven chapters, and the following list of chapter headings will give an idea of its scope: Crude Petroleum; the Refining of Petroleum; the Refined Products; Friction and Lubrication; Lubrication of Internal Combustion Engines; Automobile Lubrication; the Lubrication of Electrical Machinery; the Lubrication of Steam Cylinders and Steam Engines; the Lubrication of Steam Railways; the Lubrication of Cotton Mills and Other Textile Mills; the Lubrication of Miscellaneous Plants and Machines; Physical Methods of Testing Lubricating Oils; Chemical Methods of Testing Lubricating Oils; Lubricating Greases; Methods for Testing and Analysis of Greases; Animal and Vegetable Oils; Methods of Testing Fatty Oils; Specifications for Fatty Oils; Specifications for Steam Cylinder Oils; Specifications for Turbine Oils; Specifications for Cylinder Oils for Internal Combustion Engines; Specifications for Transmission Oils and Crankcase Oils; Specifications for Compressor Oils; Specifications for Engine Oils, Paraffin Oils and Car Oils; Specifications for Printing Oils and Light Machine Oils; Specifications for Transformer Oil, Petroleum Residues, and Miscellaneous Oils; Standard Government Specifications for Lubricants; Specifications for Cutting Oils; Specifications for Greases and Graphite; Specifications for Boiler Compounds and Cotton Waste; Specifications for Fuel Oil; Specifications for Kerosenes; Specifications for Gasoline; Gasolines; Kerosene; and Tables.

NEW CATALOGUES AND CIRCULARS

Griscom-Russell Co., 90 West St., New York City. Bulletin 260, illustrating and describing Reilly feed-water heaters for power plants.

Casehardening Service Co., 2282 Scranton Road, Cleveland, Ohio. Circular advertising "Bohnite," a casehardening material for hardening gears and other steel parts.

Scientific Materials Co., Pittsburg, Pa. Circular advertising the F. & F. direct-reading optical pyrometer for measuring temperatures from 1500 to 4000 degrees F.

Electric Furnace Co., Alliance, Ohio. Bulletin 9-B, illustrating and describing Baily electric furnaces for melting non-ferrous metals and for annealing and heat-treating.

Gas Producer & Engineering Corporation of New Jersey, 15 Park Row, New York City. Bulletin 96, illustrating and describing the Galusha suction Type L stationary gas producer.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Leaflet 3461, illustrating and describing the Westinghouse automatic current regulator for electric arc furnaces with movable electrodes.

Buffalo Forge Co., Buffalo, N. Y. Catalogue 460, of Buffalo standard pipe coil heaters, giving sizes, capacities, and other data of use in figuring the heater requirements for fan heating and ventilating work.

Weldon Tool Co., 321 Frankfort Ave., Cleveland, Ohio. Circular of Weldon double end-mills and holders, designed so that both ends of the tool can be used, in order to increase production and save time in sharpening.

Hobart Bros. Co., Troy, Ohio. Bulletin 66, advertising the HB thirty-two battery charging set. Bulletin 73, advertising the HB line of ball-bearing equipped battery chargers, lighting outfits, generators, and motors.

General Electric Co., Schenectady, N. Y. Bulletin 46209, illustrating and describing Thomson direct-current astatic watthour meters, Types CS and CS-3, for measuring direct-current installations of relatively large size.

Standard Pressed Steel Co., Philadelphia, Pa. Circular giving dimensions and prices of Hallowell interchangeable steel bench legs, for supporting benches and tables in machine shops and other manufacturing establishments.

Strauss & Buegeleisen, 16 Hanover Place, Brooklyn, N. Y. Circular advertising "Resistal" goggles which are made with non-shatterable lenses for protecting the eyes of workmen against metal chips, great heat, light, etc.

Wagner Electric Mfg. Co., St. Louis, Mo. Circular containing a reproduction of a letter relating to the performance of a Wagner electric motor that was under water for thirty-six hours and was able to start without cleaning or drying.

Canton Foundry & Machine Co., Canton, Ohio. Catalogue of Canton alligator shears, which are built in various styles and sizes, for cutting from 1 to 3 inches square, inclusive. These machines are made in high and low knife, belt and motor drive, stationary and portable types.

Oliver Instrument Co., Adrian, Mich. Folder advertising the Oliver sawing, filing, and lapping machine and showing a view of the machine engaged in cutting the relief on powder pocket cutters for high-explosive shells, on which operation an output of 100 cutters per day was maintained.

O. Zernickow, 15 Park Row, New York City. Circular advertising the O-Z hand tachometer-cutmeter, an instrument for recording speeds and feeds ranging between 60 and 12,000 revolutions per minute, and between 30 and 6000 feet per minute.

Cogsdill Mfg. Co., 1124 Grand River Ave., Detroit, Mich. Catalogue giving dimensions, list prices, and other data relating to the "CogsDrill" center drills, "Cogs-mill" gear-tooth rounding cutters, machine countersinks, and Morse taper shanks.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Bulletin entitled "Control of Motor-driven Steel Mill Machinery," containing a discussion of the problems involved and an outline of the Cutler-Hammer apparatus that has been used in solving these problems.

Sprague Electric Works of General Electric Co.; 527-531 W. 34th St., New York City. Bulletin 48961, descriptive of Sprague electric Type W floor-controlled hoists, which are made in capacities of from one to six tons, for operation on direct and alternating current.

Charles F. Elmes Engineering Works, Morgan and Fulton Sts., Chicago, Ill. Sheets for loose-leaf catalogue, giving specifications for hydraulic presses for straightening, forming, bending, forcing, molding, and other uses. Specifications are also given for the company's line of hydraulic pumps.

Pawling & Harnischfeger Co., Milwaukee, Wis. Circular entitled "P & H in the Leather Tanning Industry," containing an article describing the use of the electric crane in the leather industry, illustrated with views showing the application of the Pawling & Harnischfeger cranes for handling this class of materials.

Golden Co., 405 Lexington Ave., New York City. Catalogue containing an article reprinted from The Engineer describing in detail the construction of the universal measuring machine made by the Societe Genevoise d'Instruments de Physique, of Geneva, Switzerland. The illustrations show the machine in use measuring different kinds of work.

Smalley-General Co., Inc., Bay City, Mich. Circular descriptive of the Smalley-General No. 1-C thread milling machine, equipped with power traverse, which is designed for especially heavy work such as milling two- and three-pitch threads up to 5 or 6 inches long, as well as for milling lighter threads and smaller pitches at one revolution of the work.

Flather Mfg. Co., Nashua, N. H. Circular illustrating and describing Flather automatic gear-cutting machines for cutting spur gears, with a capacity for work of 30 and 40 inches in diameter and 10 inches face. These machines can also be supplied with bevel-gear and clutch-cutting attachments for milling miter, bevel, skew bevel, and face gears, and toothed clutches.

A. & F. Brown Co., 79 Barclay St., New York City. Catalogue 66, covering the line of power transmission machinery made by this company. Tables are given listing dimensions and prices of steel shafting, collars, couplings, clutch-shifting devices, pulleys, countershafts, pulley stands, hangers, journal boxes, pedestals, wall frames and brackets, sole plates, belt tighteners, etc.

Doyle-Wall Machine & Tool Co., 318-324 Pearl St., Syracuse, N. Y. Circular descriptive of a precision taper-measuring gage, which comprises a double sine bar and angle measuring gage. This gage is used for originating tapers and duplicating tapers already in use, and will give the correct taper per foot, as well as the measurement of any desired taper from 0 to 4 inches per foot.

Armstrong Cork Co., Pittsburg, Pa. Catalogue entitled "Nonpareil Insulating Brick," containing 72 pages treating of the insulation of high-temperature industrial equipment, such as boilers, furnaces, stills, hot blast stoves, ovens, kilns, etc. The book contains general information on the subject of heat insulation, and presents the results of heat transmission tests, and operating records with and without insulation.

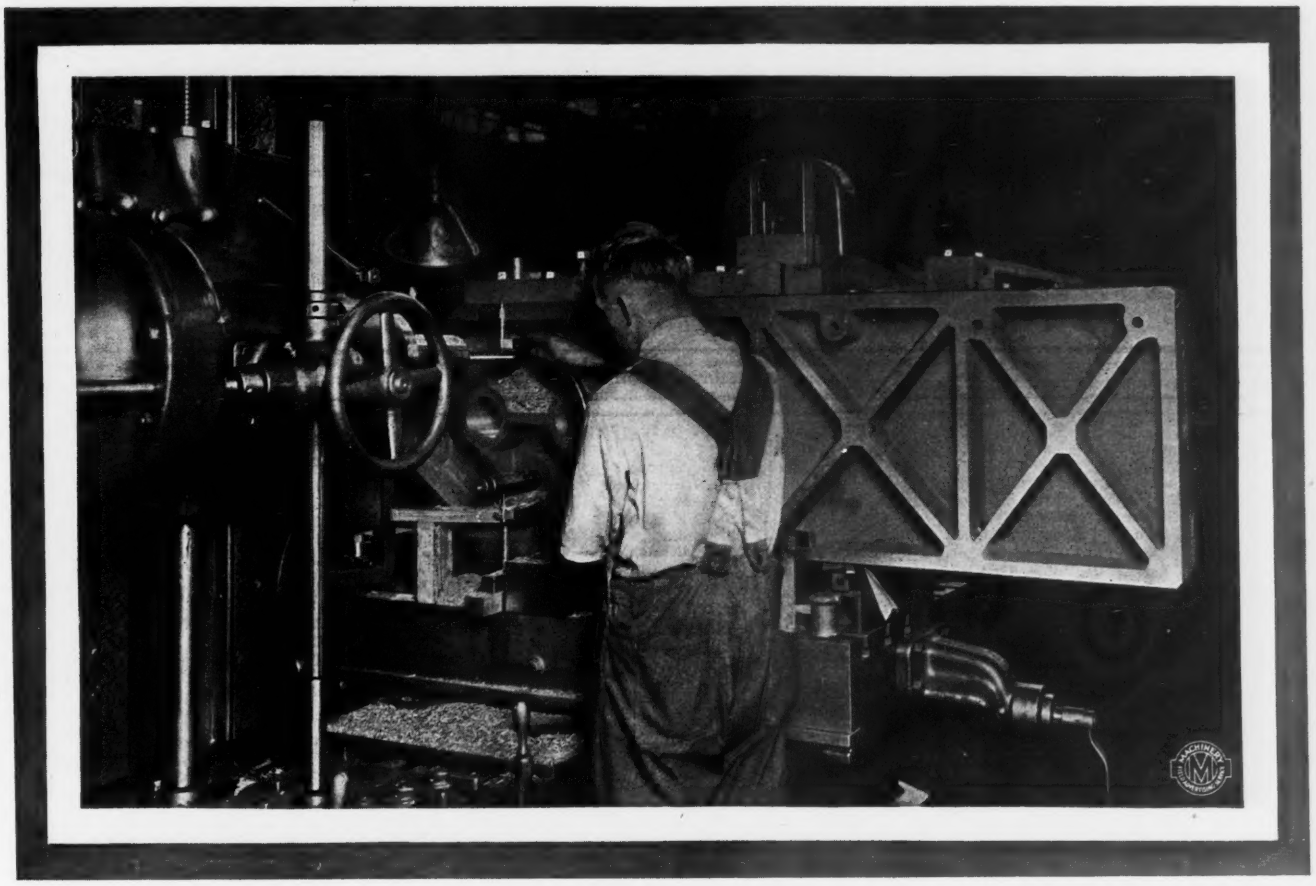
Bastian-Blessing Co., West Austin Ave. at La Salle St., Chicago, Ill. Catalogue 20, descriptive of "Rego" welding and cutting apparatus, giving prices and specifications for the various outfits, as well as details concerning the torches and regulators. Circular entitled "A New Principle in Welding and Cutting Apparatus," describing the features of construction of the "Rego" welding and cutting torches.

Acme Machine Tool Co., Cincinnati, Ohio. Catalogue entitled "Cincinnati Acme Efficiency," describing and illustrating different classes of machine work which can be done to advantage on Cincinnati Acme turret machinery, both on the flat turret and high type turret machines. The illustrations show work that has actually been done in a large number of plants, and figures are given concerning the rate of production obtained.

Oliver Machinery Co., Grand Rapids, Mich. Circular descriptive of the Metcalf grinding wheel dresser, which is made in three styles—Types A, B, and C—for hand dressing, dressing with tool-post, and for working in tight places, respectively. This dresser is designed primarily for fine wheels of 1 inch or less in thickness. The circular contains illustrations showing the Type A grinding wheel dresser in use on a band resaw sharpener; the Type C dressing wheel applied to a cutter grinder; and the Type C dressing wheel engaged in sharpening a cut-off saw.

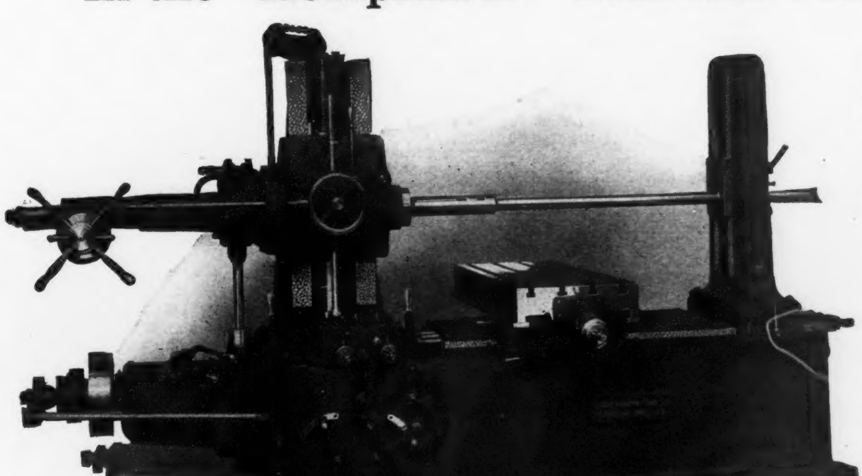
Fafnir Bearing Co., New Britain, Conn. Booklet 20, entitled "Fafnir Ball Bearings for Your Machines," describing the construction of this type of ball bearing, methods of mounting, lubrication, and types of closures. One section of the catalogue shows actual examples of the application of Fafnir ball bearings to drilling machines, lathes, automatic machines, grinding machines, portable tools, and electric motors. Reproductions of blueprints showing cross-sections illustrate the methods of mounting Fafnir ball bearings on different types of machines.

Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill. Catalogue 380, containing 96 pages covering the Link-Belt line of standardized monorail electric hoists, as well as overhead electric traveling cranes in capacities of from ½ to 3 tons, in-



TWO LUCAS "PRECISION" BORING, MILLING AND DRILLING MACHINES

In the "Kempsmith" Tool and Fixture Department



The far-famed accuracy of Kempsmith Millers has its source in the "Kempsmith" Toolroom, where accuracy is built into tools, jigs, fixtures, etc., and duplicated in the machines they are used to produce. Of the two Lucas "Precision" Boring, Milling and Drilling Machines in this department, the first is three years old and its services sold the other.

Wherever holes must check up within 0.001" center to center, wherever tolerances are only a matter of tenths of thousandths—as in the jig here shown being machined—one or the other of these heavy duty "Precision" machines is sure to be assigned, their "excellent workmanship and permanency of alignment" being the reason given for their popularity.

Lucas "Precision" Boring, Milling and Drilling Machines are made in three sizes with 3", 3¾" and 4½" spindles. Details or salesman on request.

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U. S. A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Aux Forges de Vulcain, Paris. Allied Machinery Co., Turin, Barcelona, Zurich. Benson Bros., Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

clusive. Tables of weights, clearance dimensions, and speeds are included. The book is illustrated with a large number of views showing this equipment in operation in foundries, machine shops, and factories of various kinds. Copies can be obtained from the main office of the company or from any branch office.

R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Booklet entitled "Multi-cuttings," descriptive of the LeBlond semi-automatic lathe for handling work which is centered, chucked, or held on arbors, up to 9 inches in diameter by 16 inches long. The machine is equipped with multiple tool-blocks for rapid production. The latter part of the catalogue contains a large number of views showing the range of possibilities of the multiple cutting tool principle. The operations illustrate special tool equipment laid out by the engineering department for a guaranteed production on certain jobs.

Cincinnati Planer Co., Cincinnati, Ohio. Catalogue illustrating the Cincinnati line of planers as well as the improved features which have recently been incorporated in these machines, among which are power rapid traverse to heads; forced lubrication to vees; herringbone gears; box arch; double-plate box table; enclosed top of bed; and safety stops for elevating device. The material relating to the new features is followed by descriptions and illustrations of the different types of drives; standard and medium types of machines; widened type of planers; open-side planers; and railroad type planers.

Flexible Steel Lacing Co., 4971 Lexington St., Chicago, Ill. Bulletin entitled "Short-cuts to Power Transmission—A Handbook for Belt Users," containing a variety of general information covering the entire process of selecting, ordering, and installing belting. Some of the subjects discussed are: Considerations in Belt Buying; Kinds of Belts; Belts and Their Uses; Technical Belting Problems; Care of Belts—Belt Dressings; Making Belt Joints; Belt Fasteners; Alligator Steel Belt Lacing; Leather Lacing; Belt Calculations; and Causes of Belt Troubles. Copies will be sent to readers of MACHINERY upon request.

Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill. Catalogue B-20, giving data on the Armstrong tool-holders for turning, boring, threading, knurling, cutting off, planing, slotting, and drilling; the Armstrong system of construction embodies an inserted cutter held in a permanent supporting shank or holder, which is adapted to all classes of work from the lightest to the heaviest. Dimensions, capacity, weight, and prices are also given for drill vises, lathe dogs, clamps, drill sleeves and sockets, ratchet drills, and wrenches. Several new tools are introduced in this catalogue, among which are the spring threading tool shown on page 27 and three new sizes of the Armstrong knurling tool shown on page 31.

Walworth Mfg. Co., Boston, Mass. Export catalogue 35, 400 pages, 6 by 9 inches, bound in cloth. This book is printed in English, Spanish, Portuguese, and French, for distribution primarily in foreign countries. It is intended for use only in countries where the British standard thread is used, and will not be distributed in the United States; catalogue 78 has been prepared to cover the field in this country, and shows a full line of American thread fittings, valves, etc. Export catalogue 35 covers the complete line of pipe fittings, valves and tools made by the Walworth Mfg. Co., which includes malleable-iron fittings, standard-weight cast-iron flanged fittings, extra-heavy cast-iron flanged fittings, cast-steel fittings, power plant piping, pipe and tubes, "Kewanee" union specialties, brass gate valves, iron and steel gate valves, brass valves and cocks, iron valves and cocks, steam specialties, engine and boiler trimmings, pipe tools, drive well points, and ammonia valves and fittings. The arrangement is such that the data is given in the same sequence in each language on each page, and as considerable matter has to be included on one page with this arrangement, the book is printed on yellow paper to increase its legibility. Great care has been taken to guard against errors in translation, the material having been checked and rechecked several times. A complete index in the four languages is included.

TRADE NOTES

Colburn Machine Tool Co., announces the removal of its entire business from Franklin, Pa., to its new plant at 1038 Ivanhoe Road, Cleveland, Ohio.

Dale-Brewster Machinery Co., Inc., 56 Lafayette St., New York City, announces that the firm name has been changed to the **Dale Machinery Co., Inc.**

Churchill-Morgan-Crittsinger, Inc., Worcester, Mass., announces that it has made a 15 per cent reduction in the prices of its internal grinding machines.

Westinghouse Union Battery Co., Swissvale, Pa., announces that its factory, which is equipped for quantity production, is now in operation on the production of batteries.

National Tool Co., Cleveland, Ohio, has opened a new office at 988 Union Arcade Bldg., Pittsburg, Pa. R. T. Brown, will be in charge of the new office, and will be assisted by J. A. Powell.

Wagner Electric Mfg. Co., St. Louis, Mo., has removed its Salt Lake City office to 59 W. Broadway, and has opened a service station at the same address. L. Brandenburger will continue in charge as branch manager.

W. J. McKee, machine tool dealer at Detroit, Mich., has opened a large store and show-room at 99 Bates St. Mr. McKee handles a general line of tools and specializes on Hisey-Wolf portable tools and National lathes.

American Machine Products Co., 18th and Howard Sts., Detroit, Mich., manufacturer of "Stubby" reamers, milling cutters, drills, and other tools, has just completed a large addition to its plant that will nearly double the capacity.

Ackerman Bros. Co., Inc., of New York City, manufacturers' representative and jobber, announces that in order to centralize its business it has removed its office from 95 Liberty St. to its store at 301 W. 4th St., corner of Bank St.

Thompson Grinder Co. is now located in its new plant at W. Main St., Springfield, Ohio. The building is a one-story steel and concrete structure, and will be devoted entirely to the manufacture of the Thompson line of precision grinding machinery.

Skinner Chuck Co., Inc., New Britain, Conn., has recently adopted a trademark to identify its product, which represents an alligator in the form of a letter "S," superimposed on a solid black circular background with the words "Skinner Chucks" around the outside.

Bearings Co. of America, Lancaster, Pa., manufacturer of thrust ball bearings and "Star" ball retainers, has recently completed a new concrete and steel building, which will increase the capacity of the plant about 50 per cent. The company has also recently erected a new power plant.

Brinkman Engineering Co., 1001 E. 3rd St., Dayton, Ohio, has been organized by L. G. Brinkman, formerly superintendent of the Federal Tool & Machine Co., of Dayton. The company has erected a new factory and will design and manufacture tools, jigs, fixtures, dies and special machinery.

Weightman & Steigely, 21 N. La Salle St., Chicago, Ill., industrial engineers and architects, have been organized to take over the business formerly conducted under the name of Hugh E. Weightman, industrial engineer. The firm announces that it will be glad to receive catalogues on machines, tools, etc.

La Belle Iron Works, Steubenville, Ohio, has become a subsidiary company of the new Wheeling Steel Corporation. The officers are D. A. Burt, president; H. D. Westfall, vice-president in charge of sales; G. B. LeVan, vice-president in charge of operations; W. B. Higgins, secretary; and H. P. Beswick, treasurer.

Ward Tool & Forging Co., Latrobe, Pa., manufacturer of punches, dies, reamers, tools, and forgings has made arrangements to have John E. Love of John D. Scott, Inc., Detroit, Mich., represent the company in the state of Michigan and the northwestern part of Ohio. Mr. Love's offices are at 1156 Penobscot Bldg., Detroit.

Reed-Prentice Co., Becker Milling Machine Co., and **Whitcomb-Blaisdell Machine Tool Co.**, 53 Franklin St., Boston 9, Mass., has opened a branch office in Philadelphia under the management of G. S. Haven, who was formerly with the Whitcomb-Blaisdell Machine Tool Co. at Worcester. The new office is located at 514 Liberty Bldg.

Machine & Stamping Co., Ltd., 1209 King St., W., Toronto, Canada, manufacturer of automobile transmissions, differentials, screw machine parts, metal stampings, spark plugs, etc., announces that the firm name has been changed to **Russell Gear & Machine Co., Ltd.** The management will remain the same, the officers being T. A. Russell, president; Lloyd Harris, vice-president; and David Ayr, general manager.

J. H. Wilhelm, Inc., 42 W. 39th St., New York City, consulting engineers engaged in production control, factory organization, lay-out and research work, appraisals, inspection, systematizing, supervising, and planning machining operations, have published a folder showing examples of automatic machines which the company has installed for increasing production, parts that have been tooled for quantity production, die designs, etc.

Williams Machine Co., Poultney, Vt., has opened a machine shop to manufacture special machinery, dies, jigs, etc. Modern equipment including planers, lathes, grinders, radial drilling machines, presses, shears, spliners, and milling machines has been installed, and the shop is now ready for operation. Robert H. Williams has had forty years' experience in this line of work, and Russell I. Williams has been connected with the Ruggles Machine Co., of Poultney, Vt., for the last sixteen years.

Kelly Reamer Co., Cleveland, Ohio, has recently moved into its new plant at 3705 W. 73rd St., which has been designed to meet the particular requirements of the company's business. Extra large vault space has been provided to accommodate both its own and its customers' drawings. Improved machinery and equipment is being installed for producing the Kelly floating adjustable reamer. The plant is located in the new manufacturing district at the southwest side of the city, convenient to the car lines.

Chapin & Baker Mfg. Co., Syracuse, N. Y., has outgrown its factory on Edison St., and has recently purchased a factory site in east Syracuse where a machine shop, 66 by 180 feet, will be erected. This will be followed by an office building, 40 by 98 feet, and later by a hardening plant, 40 by 60 feet. The officers of the concern are Frank E. Baker, president, and E. I. Chapin, treasurer and general manager. This concern is engaged in the production of small tools, reamers, end-mills, and in general tool manufacturing.

St. Louis Pump & Equipment Co., has been organized in St. Louis, Mo., to engage in the manufacture and installation of liquid handling equipment, especially as adapted to railroad and industrial uses. Executive offices have been opened in the International Life Building, and temporary factory space has been obtained in the western industrial section of the city. John C. Roberts, Jr. is president of the concern, and C. C. Fredericks of Fort Wayne, Ind., who has made surveys of oil handling facilities and equipment on railroads throughout the United States, is general manager.

Detroit Twist Drill Co., Detroit, Mich., has established a plant in Walkerville, Ontario, Canada, which will be known as the **Canadian-Detroit Twist Drill Co.** High-speed drills and reamers will be manufactured and a complete stock will be built up as soon as possible. The officers of the new company are as follows: President, Muir B. Snow; vice-president, Lewis H. Jones; treasurer, H. H. Sanger; secretary, P. C. Hill; manager, R. A. B. Goodman; and superintendent, George Johnston. Manufacturing operations have already begun and it is expected that the first drills will be completed by November 15.

Dwight P. Robinson & Co., Inc., 125 E. 46th St., New York City (with which Westinghouse, Church, Kerr & Co., Inc., have recently consolidated) have established a new branch office in Youngstown, Ohio, in the Home Savings & Loan Bldg., with C. I. Crippen in charge. The company recently moved its Cleveland office from the Leader News Bldg. to the Citizens Bldg., and H. P. Clawson, who was for several years a member of the Chicago staff, has been transferred to Cleveland to take charge of this office. The company now maintains branch offices in Pittsburg, Youngstown, Cleveland, Chicago, Dallas and Los Angeles, and Sao Paulo, Brazil.

Norton Co., Worcester, Mass., announces that an office has been opened for the grinding machine division of the company at 304 Penway Bldg., 241 N. Pennsylvania Ave., Indianapolis, Ind., under the direction of Walter F. Rogers, district representative. The establishment of this branch office will not affect the distribution of Norton grinding wheels, which will be handled as in the past by the Vonnegut Hardware Co. The company has also opened a branch office for the grinding machine division in Pittsburg at 230 Fifth Ave., under the direction of Paul R. Hawkins, district manager. The distribution of grinding wheels will be handled as previously by Somers, Fitler & Todd Co., 327 Water St.

Luster Machinery Co., 917 Arch St., Philadelphia, Pa., manufacturer of machine shop and railway equipment, has sold its entire business, consisting of all liabilities, stock on hand, and good-will, to **Fairbanks, Morse & Co.** The latter company will operate at the same address, as a separate branch, and will enlarge the machine tool business, in addition to handling its regular line of engines, motors, and pumps. E. J. Luster, president of the Luster Machinery Co., is now manager of the machine tool division of Fairbanks, Morse & Co., with headquarters at Philadelphia. The entire personnel of the Luster Machinery Co. will remain with Fairbanks, Morse & Co. W. D. Dunn is Philadelphia branch manager.

American Car & Foundry Co., 165 Broadway, New York City, is extending its plant at Buffalo, N. Y. The new plant will be used for building all-steel cars, and will have a capacity for turning out twenty to thirty cars per day. It will be equipped throughout with modern machinery and labor-saving devices. In addition to the new car-building plant, an up-to-date office building will be erected on property recently acquired on Babcock St. W. H. Sanford, for many years district manager of the Buffalo plant, has been appointed assistant vice-president, and will be placed in charge of sales. Mr. Sanford will be succeeded as Buffalo district manager by Andrew H. Gairns, who now holds a similar position in Chicago.

W. E. Seymour Mfg. Corporation, Milwaukee, Wis., has been incorporated with a capitalization of $200,000. The officers are as follows: W. E. Seymour, president; J. A. Lee, vice-president and general manager; M. L. Buckley, secretary; C. J. Gilbert, treasurer; and E. E. Hirschhauter, chief engineer. The company has been formed to manufacture a variety of motor parts, but for the present all its facilities will be devoted to the production of piston rings. A manufacturing plant has been purchased at Lisbon Ave. and Thirty-first St., and options on adjoining property have been taken as a provision for expansion when it becomes necessary. Machinery and equipment is arriving daily, and it is expected that actual production will begin the latter part of November or early in December. The temporary location of the offices is at 266 Plankinton Arcade, Milwaukee.